State of California
THE RESOURCES AGENCY
Department of Water Resources

BULLETIN No. 152

EWING PROJECT

Feasibility Study

SEPTEMBER 1965

HUGO FISHER
Administrator
The Resources Agency

EDMUND G. BROWN
Governor
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WILLIAM E. WARNE
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FOREWORD

Bulletin No. 152, "Ewing Project Feasibility Study", reports upon a one-year study conducted by the Department of Water Resources as directed by the Legislature in 1964.

The study was undertaken to evaluate the feasibility of the Ewing Project as a source of urban water for the Trinity County Waterworks District No. 1. The district serves the community of Hayfork from a surface supply and is faced with water shortages in the summer months. The Ewing Project would provide off-stream storage of winter flows for use during the dry period and would provide a limited potential for recreation use.

The study concludes that the project is engineeringly feasible, economically justified, and financially feasible. It is recommended that the Trinity County Waterworks District No. 1 take steps to proceed toward construction, beginning by (1) making application for the necessary water rights and (2) investigation of possible sources of financing.

William E. Warne

Director

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The Resources Agency
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The Department of Water Resources is grateful to the residents of Hayfork Valley for their cooperation during this study. Special thanks are extended to the employees and officials of the Trinity County Waterworks District No. 1.

CHAPTER I. SUMMARY OF STUDY

The proposed Ewing Project would replace an existing inadequate source of municipal water for the Trinity County Waterworks District No. 1 which serves the community of Hayfork in central Trinity County. The results of the one-year feasibility study reported in this bulletin are that the Ewing Project is economically justified and financially feasible. It is recommended that the district take the steps necessary to proceed toward construction.

Need For Study

The Trinity County Waterworks District No. 1 was formed in 1951 to construct and operate a municipal water system to serve the Hayfork Valley area. A water system, which draws water directly from nearby Big Creek, was completed in 1953. The system was designed to serve 250 connections, but this demand was exceeded by 1958. The system is presently serving almost 400 connections and a population of about 1,300. The unregulated summer flow of Big Creek is often not sufficient to meet all of the demands upon it. To provide a safe, adequate supply at present, and to provide for future expansion, it is now necessary for the district to develop additional or alternative sources of water.

The district considered construction of a reservoir for both irrigation and municipal water supply but found that such a project would be very difficult to finance. At the request of Assemblywoman Pauline L. Davis, the Department of Water Resources conducted a brief survey in 1963 of possible small projects that would meet the immediate water supply needs of the district. The Department concluded that the Ewing Project, located on Ewing Gulch, was the most promising. A reconnaissance study of the project was completed in 1964, and it was recommended that the project be considered by local interests for a feasibility study. The Legislature, at the 1964 session, directed the Department of Water Resources to conduct a feasibility study of the Ewing Project.

Description of Project

The Ewing Project, as shown on Plate 1, would consist of a dam and reservoir on Ewing Gulch, diversion facilities to convey excess flows from Big Creek to the reservoir, and a pumping plant to lift water to a treatment plant

adjacent to the district's existing regulation reservoir. Ewing Dam would be about 60 feet high and would form a 42-acre reservoir with a gross storage capacity of 820 acre-feet.

Scope of Study

Previous studies by the Department concluded that the Ewing Project was the most economical means of meeting the future water needs of the Hayfork area; therefore, this feasibility study was directed almost entirely to consideration of the engineering feasibility, economic justification, and financial feasibility of the Ewing Project itself. However, limited study was given to alternative means of solving the water supply problem.

No definite study area boundary was established. The study area was considered to include all that area of Hayfork Valley included within the Trinity County Waterworks District No. 1 at any given time. It was further assumed that the district would grow in an orderly manner consistent with reasonably efficient extension of water service.

Conclusions

1. The Trinity County Waterworks District No. 1 needs an additional or alternative source of municipal water to operate the existing Hayfork water system safely and to provide for future expansion.

2. The unregulated runoff of Big Creek is not adequate in dry years to supply the present demands of the district on a safe-yield basis, even if upstream irrigation diversions were stopped.

3. Hayfork Valley is underlain by compact sediments of the Weaverville formation with very little potential for development of ground water supplies. Therefore, ground water cannot be expected to meet the anticipated future water demands.

4. The Ewing Project, which would store excess winter runoff of Big Creek for domestic use, represents the best means of alleviating the current water shortages and providing for future growth.

5. To achieve the maximum excess of benefits over costs, the Ewing Project should be sized for the demands projected to occur about 30 years in the future. The main feature of the Ewing Project would be a 60-foot

high earthfill dam in Ewing Gulch, impounding a 42-acre reservoir with a gross storage capacity of 820 acre-feet. In conjunction with a diversion capacity of about 10 cubic feet per second from Big Creek, the project would have an annual yield of about 800 acre-feet.

6. No other project appears likely as an economic source of additional water after the 30-year period for which the Ewing Project would be sized. Therefore, the design of the Ewing Project should provide for eventual enlargement.

7. Inclusion of water-contact recreation in conjunction with the Ewing Project is not economically justified. However, the reservoir would provide good warm-water fishing which would produce recreation benefits with a present worth of about $120,000. Thus, fishery enhancement and nonwater-contact recreation should be included as a primary project purpose.

8. Due primarily to the expected growth of algae in the reservoir, it will be necessary to provide complete treatment facilities for water from the Ewing Project. These facilities should be sized to meet the demand expected after 10 years, with provision for subsequent enlargement.

9. The Ewing Project is engineeringly feasible; no unusual problems were noted during the geologic and design studies.

10. Based on an interest rate of 4 percent and a period of analysis of 50 years, the present worth of benefits attributable to the project ($1,605,000) exceeds the present worth of costs attributable to the project ($1,514,000). The ratio of benefits to costs is 1.06:1. Thus, the project is considered to be economically justified.

11. The initial capital expenditure required for the Ewing Project is estimated to be $761,000. A total of $84,000 of this capital cost was allocated to fisheries enhancement and recreation.

12. The Ewing Project is considered to be financially feasible since estimated revenues would be sufficient to repay the reimbursable costs. Based on project financing by the State under the Davis-Grunsky Act, the total additional cost to the average consumer of the Ewing Project would be about $20 per year.

13. The Ewing Project water supply would be more dependable, more abundant, and of better quality than the existing water supply.

Recommendations

It is recommended that:

1. The Trinity County Waterworks District No. 1 adopt the Ewing Project essentially as set forth in this bulletin as its official plan to provide new water supply facilities to meet its existing and future water needs.

2. The district take immediate steps to obtain water rights necessary for the Ewing Project.

3. The district investigate all possible private, state, and federal sources of financial assistance, including the Davis-Grunsky Act.

CHAPTER II. BACKGROUND INFORMATION

Hayfork Valley is the largest valley area in Trinity County. It is unique among the major valleys of the surrounding area in that there are no plans currently under study which would inundate it as a part of a major water development project. This chapter describes the valley, its water resources, and the problems and events leading to the feasibility study of the Ewing Project.

Area of Study

The study area included the present Trinity County Waterworks District No. 1 and adjacent areas of Hayfork Valley which would logically be served by the district in the future.

Location

Hayfork Valley is located in the central portion of Trinity County, about 40 air miles west of Redding. The valley floor area includes some 4,000 acres and ranges from 2,250 to 2,500 feet in elevation. Surrounding mountains range up to 6,000 feet in elevation. A total of about 19,000 acres in and around Hayfork Valley are completely surrounded by lands of the Trinity National Forest. Hayfork Valley is served by State Highway 3 which joins Route 299 at Douglas City after running 23 miles over the 3,650-foot Hayfork Summit. The major stream of the area is Hayfork Creek which flows westerly through Hayfork Valley to join the South Fork Trinity River at Hyampom.

Ewing Dam and Reservoir would be located in Ewing Gulch, a minor tributary of Hayfork Creek, about 1 mile northeast of Hayfork. Water would be diverted to Ewing Reservoir from Big Creek about 3 miles above its confluence with Hayfork Creek. Plate 1 shows the Hayfork Valley area and the features of the Ewing Project.

Climate

Hayfork Valley has warm summers and mild winters. The average maximum temperature during the summer is over 90 degrees, and the average minimum winter temperature is slightly below freezing. However, crop-killing frost is possible

during any month of the year and the growing season averages only about 100 days.

Precipitation at the Hayfork Ranger Station, about 0.7 mile south of Ewing damsite, averages 31 inches per season and ranges between 14 and 54 inches. About 80 percent of the seasonal precipitation occurs from November through March; very little precipitation occurs in July and August. The annual snowfall in Hayfork Valley averages about 2 feet, with December and January being the months of highest average snowfall. A total of 77 inches of snow was recorded in January 1916.

Geology

Hayfork Valley was formed by a combination of downfaulting and erosion of a large body of soft, poorly consolidated sedimentary rocks known as the Weaverville formation. Sediments of this formation underlie nearly all of the valley floor and the low terraced hills along its northerly margin. The Weaverville formation consists of a thick series of clayey gravel, sandy silt, sandy clay, sandstone, shale, lignitic shale, tuff, and conglomerate. Original sediments were deposited during early Tertiary time under floodplain and shallow lake conditions in an ancestral valley. Erosion has since removed most of the original deposit, but a remnant has been preserved by downfaulting into the more resistant older rocks. These older rocks form the high mountains which surround Hayfork Valley. Maximum thickness of the eroded Weaverville beds, near the central portion of the valley, is possibly as much as 2,000 feet.

Adjacent to Hayfork Creek and its tributaries, deposits of Recent alluvium up to 25 feet thick overlie the Weaverville beds. The alluvium consists of moderately permeable mixtures of gravel, sand, and silt. These sediments have been worked extensively for gold, as attested to by several miles of dredger tailings along Hayfork Creek upstream from the community of Hayfork.

Development

Towns of Trinity County were settled during the middle of the 19th century. Agricultural lands were cleared and planted to produce food for the miners. Mr. E. M. George recognized the agricultural potential of Hayfork Valley as early as 1850. During 1851, he organized a party of settlers to

cross the mountains from Weaverville and Steiner Flat (an early settlement near the present Douglas City) to stake out ranches and clear land for planting in Hayfork Valley. The first settlement of the valley was called Kingsberry, later Hay Town, and finally Hayfork.

By 1860, Hayfork Valley's population had increased to about 1,200 and practically all land suitable for agriculture was being improved. At that time, produce from Hayfork Valley, which included grain, potatoes, beans, butter, eggs, and livestock, was sufficient to supply the entire population of Trinity County. With the decline of mining activity, the population of this agricultural center dropped to about 130 in 1910, increased slowly to 200 in 1930, and by 1940 had reached approximately 250. During the late 1940's, harvest of commercial timber, coupled with development of other economic activities, resulted in an increase in population to 650 by 1950. The 1960 population of the valley is estimated to have been 2,050, of which approximately 1,250 resided within or immediately adjacent to Hayfork.

The economy of the Hayfork Valley area is based primarily on cattle and lumbering. About 900 acres of pasture and alfalfa are under irrigation at present and several lumber mills are in operation in the valley and the surrounding area. Lumbering in the Hayfork area is not expected to increase materially in the future since recent harvests have been somewhat in excess of the sustained yields. However, some increase in local milling and processing of the harvest within the area is anticipated. No pulp or paper manufacturing activity is expected because of transportation and market conditions and water pollution restrictions. The potential of other industrial and commercial activities in the Hayfork area is limited by the accessibility of the area. The nearest rail service is at Redding and Red Bluff, and there is very little through highway traffic.

In the future, Hayfork Valley will probably be surrounded by large water development projects on the Trinity and South Fork Trinity Rivers. These projects would bring about a large increase in recreation use in the Trinity County area. The Hayfork area would share in the economic growth promoted by these projects to some extent, depending upon the plans eventually selected for highway relocations around the reservoirs.

Water Supply

Water for the proposed Ewing Project would be derived from runoff of Ewing Gulch and from diversion of a part of the winter and spring runoff

of Big Creek. The following paragraphs discuss the water supply of Hayfork Valley in general with special emphasis on Ewing Gulch and Big Creek.

Precipitation

Long-term records are available for precipitation at the Hayfork Ranger Station, located approximately 0.7 mile south of the proposed damsite. The published precipitation record of this station extends from July 1915 through January 1934, and from July 1948 to the present. Estimates of unrecorded precipitation at Hayfork Ranger Station since July 1899 were based on records of precipitation at Weaverville Ranger Station. The 50-year (1905-06 through 1954-55) mean seasonal precipitation at Hayfork Ranger Station is 31 inches, of which 80 percent normally occurs during the five-month period, November through March. The lowest seasonal precipitation total since 1915 is 13.53 inches during 1923-24; the highest seasonal total is 54.39 inches in 1957-58.

The average mean seasonal precipitation over the Big Creek and Ewing Gulch drainage basins was estimated to be 43 and 35 inches, respectively. These values were estimated from an isohyetal map compiled for other studies being conducted by the Department.

Runoff

Hayfork Creek is the principal stream of the Hayfork Valley area. Its headwaters are about 18 miles southeast of Hayfork at the 5,000-foot elevation, and its drainage area at the point where it enters the east end of Hayfork Valley is about 93 square miles. An additional 176 square miles drain into Hayfork Creek above its point of exit at the west end of the valley. Big Creek is one of the major tributaries, joining Hayfork Creek near the east end of the valley and draining an area of about 27 square miles.

Two gaging stations have been operated in Hayfork Valley. A United States Geological Survey station has been in operation on Hayfork Creek since 1956 at a point about 3 miles upstream from Hayfork Valley. The 50-year mean seasonal natural runoff from the 87.2-square-mile drainage area has been estimated by the Department of Water Resources as 81,900 acre-feet. The second gaging station, operated by the Department, is located on Big Creek at the State Highway 3 bridge, about one-quarter mile above the confluence of Big Creek and Hayfork Creek. This gage has been in operation since February 1957.

It is located below the irrigation diversions in Big Creek Valley and the diversion by Trinity County Waterworks District No. 1.

The natural runoff of Big Creek near Hayfork was estimated back to 1910 as a part of the Department's Coordinated Statewide Planning studies. Big Creek natural flows were estimated by correlation with the estimated natural flows of Hayfork Creek near Hyampom, which were based on previous correlations with the South Fork Trinity River near Salyer and the Eel River at Scotia. The 50-year (1910-11 through 1959-60) mean seasonal natural runoff of Big Creek from the 27.3-square-mile drainage basin above the gaging station was estimated as 26,000 acre-feet. The minimum seasonal runoff was estimated as 3,700 acre-feet in 1923-24 and the maximum as 61,500 acre-feet in 1957-58.

Runoff of Ewing Gulch has never been gaged. The mean seasonal runoff from the 0.63-square-mile drainage area above Ewing damsite was estimated as 500 acre-feet by area-precipitation comparison with the Big Creek drainage area.

Water Use and Water Rights

About 900 acres are presently under full or partial irrigation in Hayfork Valley. Most of the irrigated land is used for pasture, alfalfa, or hay. About 500 acres are irrigated from Big Creek, about 100 from Hayfork Creek, and the remainder from tributary streams. Several diversions are made from Hayfork Creek for industrial uses in lumber mills around Hayfork. The water supply for the community is pumped from Big Creek. Numerous minor diversions are made within Hayfork Valley and the surrounding area for stock water, domestic, and mining purposes. Most diversions in the area are based on riparian water rights and many have been in use for more than 70 years.

Big Creek is an important spawning stream for steelhead trout. The adult fish migrate upstream during the winter months and spawn in March, April, and May. April is apparently the month of peak spawning activity. The hatch usually begins to emerge from the spawning gravels in June and some fry migrate downstream to the sea during the summer. However, many fry remain in Big Creek for extended periods and migrate downstream in the fall or during the following year. The steelhead spawning areas in Big Creek are located upstream from all the major diversions so it is necessary to provide fish ladders at diversion dams to permit passage of adult fish, and fish screens at the turnouts to prevent diversion of the downstream migrants.

The three major diversions from Big Creek are located upstream from the gaging station at the State Highway 3 bridge. At the uppermost, about 3 miles above the gage, gravity diversion is made at a small dam to irrigate about 400 acres of pasture on the Big Creek Ranch. This diversion has been in use since about 1890 under riparian water rights. Normally, irrigation is begun in March and continued until the winter storms begin, usually in November. However, during dry periods, irrigation water could be used in any month of the year. This diversion was monitored by the Department during the 1957 irrigation season as a part of a water resources inventory of the Trinity River Hydrographic Unit. The estimated total diversion for the season was about 2,400 acre-feet. Water not consumptively used on Big Creek Ranch returns to Big Creek above the gaging station.

The second major diversion from Big Creek is made about 0.4 mile above the gaging station to irrigate some 76 acres along State Highway 3 to the west of Big Creek. This riparian diversion is also made by gravity from a low dam and has been in use since about 1890. The estimated total diversion during the 1957 season was about 1,100 acre-feet. Return flows from this diversion flow directly into Hayfork Creek.

The third major diversion from Big Creek is made by the Trinity County Waterworks District No. 1 at a point about 500 feet upstream from the gaging station. The diversion is made by direct pumping from behind a low dam which provides practically no storage. An application was filed with the State Water Rights Board in 1952 by the district for 2.0 cubic feet per second at any time for municipal purposes. The application was approved by the board and a permit was issued entitling the district to divert. The water right has not as yet been confirmed by issuance of a license. The district's present installed pumping capacity is about 1.3 cubic feet per second.

The only confirmed appropriative water right on Big Creek is held by Mr. James R. Wood who diverts a small tributary of Big Creek for mining and domestic purposes. Mining use is limited to the period from November through June and consumptive use is negligible.

There is currently no use of Ewing Gulch waters above the damsite, but a small diversion is made downstream for stock watering.

Water Quality

Water for the Ewing Project would be obtained from the natural runoff of Ewing Gulch and diversion of water from Big Creek. Limited laboratory

analyses of samples from these sources show the waters to be of excellent mineral quality. A total of eight samples of Big Creek water obtained between 1958 and 1963 showed total hardness ranging from 85 to 123 parts per million (ppm) with no unusual amounts of any mineral. Water with a total hardness of less than 100 ppm is considered soft and from 100 to 200 ppm indicates moderate hardness. Six samples of water from Ewing Gulch were obtained during 1963 and 1964 which showed total hardness ranging from 12 to 37 ppm. Partial results of the analyses of Big Creek and Ewing Gulch waters are presented in Table 5 on page 43.

Although the mineral qualities of the Big Creek and Ewing Gulch waters are satisfactory, some difficulties are expected with color from Ewing Gulch waters, taste and odor associated with the growth of algae during prolonged storage in Ewing Reservoir, and turbidity. Four samples of Ewing Gulch water analyzed for color contained 30 to 70 units of organic color, well above the recommended maximum of 15 units. The level of color in Ewing Reservoir would be reduced by the diversion of Big Creek water into the reservoir but color would still be produced in the reservoir itself due to leaching of pigments from leaves and other vegetation from the reservoir area and watershed.

The growth of microscopic aquatic vegetation, commonly known as algae, and the decay of this vegetation, can impart objectionable taste and odor to water. While growing, this vegetation liberates oils into the water. Single-celled animal life, known as protozoa, also grow in and usually impart a fishy odor to water. Nitrates and phosphates are basic nutrients necessary for the growth of algae. The amount of these nutrients found in the waters to be impounded in Ewing Reservoir are known to be sufficient for algae growth.

Some problems with algae have been experienced in the district's existing regulation reservoir and greater problems are expected in Ewing Reservoir due to the increased storage time, the possible increase in nutrients from the watershed, and the shape and depth of the reservoir.

Turbidity, or cloudiness of water, is due to the presence of suspended matter which obstructs the passage of light through the water. High turbidity in a domestic water supply is aesthetically objectionable, but more important, may seriously impair the effectiveness of water disinfection. Much of the turbidity, that which is not in a colloidal form or caused by algae, will settle out in a reservoir of the size

proposed. Following a heavy rainfall, however, an increase of turbidity may be expected in Ewing Reservoir, the persistence of which will depend largely on the size of the suspended particles washed in from the watershed. The amount of turbidity entering the reservoir may be controlled to a degree by excluding any highly turbid waters from Big Creek through regulation of the diversion facilities.

Measures to control the growth of algae in Ewing Reservoir and to remove color, taste, odors, and turbidity from the water are discussed in Chapter IV.

Ground Water

Hayfork Valley is underlain by lake-deposited sediments of the Weaverville formation which are of very low permeability and are estimated to range up to 2,000 feet in thickness. Part of the valley floor is covered by a thin layer of unconsolidated Recent alluvium which occurs along Hayfork Creek and extends a short distance up the main tributaries. Present development of ground water in Hayfork Valley consists of one deep industrial well and numerous domestic wells. There are no irrigation wells in the valley.

The industrial well was drilled by the Trinity Alps Lumber Company about 1 mile south of Hayfork. The well is 12 inches in diameter, penetrates the Weaverville formation to a reported depth of 575 feet and yields about 50 gallons per minute. A water sample taken by the Department in 1959 showed no unusual concentrations of minerals but the water would be considered Class 3, "injurious to unsatisfactory", for irrigation use because of its high sodium percentage (88 percent). A nearby well was drilled to a depth of 282 feet and was abandoned because of low yield which resulted in drawdown to the 260-foot level after one-half hour of pumping with a three-quarter horsepower jet pump, followed by a five-hour shutdown to recover to the original level. Water from this well, and from two unsuccessful neighboring wells, with depths of 65 and 85 feet, contained considerable flammable gas. Another well 61 feet in depth was drawn down from the 25-foot to the 60-foot level by one-half hour of pumping with a pump rated at 600 gallons per hour. Recovery was at the rate of about 1 foot per hour. The above considerations indicate that the Weaverville formation has little potential as a source of ground water supply for any purpose.

Most of the domestic wells in the valley are shallow dug wells from 10 to 25 feet in depth, situated in the Recent alluvium along Hayfork Creek. The alluvium consists of moderately permeable gravel, sand, silt, and clay up

to about 25 feet thick. The average thickness of the alluvium is about 10 feet and its potential as a source of supply is limited by its low storage capacity. In the eastern part of the valley, Hayfork Creek is graded on the Weaverville formation and the Recent alluvium is recharged by the creek only during periods of high flow. In the western part, gravels extend below the streambed and are probably recharged throughout the year. The best well in the valley is located near the junction of Hayfork and Salt Creeks and reportedly produces about 60 gallons per minute from gravels which apparently have good hydraulic continuity with the creeks. The Recent alluvium is apparently capable of being recharged quite rapidly, both by infiltration of rainfall and seepage from influent streams. Water levels in the alluvium have not been measured over a period of time, but they probably decline considerably during the dry season.

The Recent alluvium deposits in the western end of Hayfork Valley present a very limited potential for the development of ground water supplies. This source was considered as a means of supplementing Hayfork's water supply during the 1963 reconnaissance study. It was concluded that the combination of low storage capacity and rapid dewatering during periods of low streamflow would render the alluvium incapable of producing water in sufficient quantities for municipal use. Pumping from the permeable gravels along Hayfork Creek would be essentially the same as pumping from the creek itself. During periods of low flow due to drought, or heavy use by upstream diverters, the water supply would have to be withdrawn from the limited storage within the alluvium. Such an operation might be suitable for a smaller community, but the available storage is insufficient to provide a safe supply to a community the size of Hayfork. Additionally, contamination could become a problem if the water supply were pumped from the creek gravels downstream, since Hayfork does not presently have a sewer system.

Trinity County Waterworks District No. 1

Trinity County Waterworks District No. 1 was formed to construct and operate a municipal water system to serve the Hayfork Valley area. In an election held in January 1951, the voters authorized formation of the district and sale of $230,000 in general obligation bonds by a vote of 174 to 46. The bonds were sold in 1952 and construction was begun on a water system with a design capacity of 250 connections. Water deliveries were begun in April 1953 with 83 users.

Existing Water System

The water system constructed in 1952-53 has been extended to serve more users but otherwise no major changes have been made in the system. All water is obtained by pumping directly from Big Creek at a small dam about 500 feet upstream from the State Highway 3 bridge. The pumping plant contains two pumps, one of 25 and one of 50 horsepower, which are capable of pumping 300 and 500 gallons per minute, respectively. The pumps can be run at the same time to pump about 580 gallons per minute but it is seldom done. The water is chlorinated at the pump plant and conveyed about 8,000 feet to a regulation reservoir northeast of the center of town. This reservoir is located near the top of a small hill at an elevation of about 2,565 feet, some 195 feet above the point of diversion from Big Creek. The reservoir is formed by a low earth dam and has a capacity of about 900,000 gallons (about 3 acre-feet). No covering is provided for the reservoir, but it is concrete lined and local inflow is excluded by a system of drainage ditches. The distribution system takes water directly from the reservoir and serves a majority of the service area by gravity. A small booster pumping station is used to supply a new subdivision located on high ground at the west end of town. The distribution system presently contains a total of over 15 miles of pipe, ranging from 12-inch to 6-inch steel pipe to 4-inch asbestos-cement and 2-inch plastic pipe. The main distribution lines are 8-inch and 6-inch sizes.

District Operations and Water Use

Trinity County Waterworks District No. 1 has experienced a steady growth in number of customers and water deliveries since service was begun in 1953. By 1958, the system design capacity of 250 connections was exceeded, and by the summer of 1964 about 370 users were being served. As long as sufficient water is available in Big Creek, the system is hydraulically capable of supplying this larger number of users.

Per capita water use was about 80 gallons per capita per day in 1953, and has increased to about 120 gallons per capita per day in 1964. All services are metered and monthly water charges are based on $5.50 minimum for up to 1,000 cubic feet and $0.10 for each additional 100 cubic feet. Lower rates prevail for cabins and trailers. The district charges a $50 hookup fee to new users and $4 for reconnection after an interruption in service.

Extensions to the system are made at the owner's or subdivider's expense although the district does perform the trenching, backfilling, inspection, and testing. Upon completion and acceptance of a new line the district assumes ownership and responsibility for operation and maintenance.

The income of Trinity County Waterworks District No. 1 is derived from water sales and taxes, with minor additional revenues derived from hookup charges, etc. Table 1 summarizes the district's operations during its first 11 years.

The 1952 bond issue carried an interest rate of 4.5 percent on $80,000 in bonds which were redeemed before 1961 and 4 percent on the remainder. A total of $10,000 in bonds is redeemable in October of each year from 1953 through 1975. The district has met all redemption dates, and a total of $110,000 in bonds was outstanding as of July 1965.

District Problems

Trinity County Waterworks District No. 1 faces two major problems with the existing water system. The first and most urgent is an inadequate supply of water at the pumping plant on Big Creek during low flow periods. The other problem involves the generally poor condition of much of the existing distribution system.

The district's pumping plant on Big Creek is located downstream from two of the largest riparian irrigation diversions in Hayfork Valley. During the summer months the unregulated flow of Big Creek is often insufficient to meet all of its water demands. At such times the Big Creek Ranch has cooperated with the district by reducing irrigation diversions to allow sufficient water to reach the district pumps. In this manner the district has been able to continue operation during periods of low flow. The system has never yet been completely out of service, but it has been necessary on several occasions to ask the customers to reduce their usage until the regulation reservoir could be refilled. Although the district has been able to "get by" in the past, a more certain long-term solution must be found. As water demands of the district continue to grow, the problem will be aggravated, and recurrence of a period of low runoff such as occurred in 1923-24 could be disastrous. In 1923-24 the district would not have been able to meet the present levels of demand even if there had been no diversion upstream. Establishment of an additional or a replacement water supply source is needed for the safety of the

TABLE 1

SUMMARY OF OPERATIONS OF TRINITY COUNTY WATERWORKS DISTRICT NO. 1

Fiscal Year	Weighted Average Number of Users	Average Use in Gal. Per Capita Per Day	Total Water Sales in Acre-feet	Assessed Value of District ($1000)	Tax Rate	District Revenue			
						Water Sales, etc.	Taxes	Other	Total
1953-54	130	78	34	$668	$2.48	$ 8,800	$16,000	$3,300	$28,100
1954-55	168	67	39	728	2.96	11,500	21,100	2,700	35,300
1955-56	182	76	48	679	2.31	11,800	15,500	1,000	28,300
1956-57	208	92	67	628	2.88	14,600	18,200	---	32,800
1957-58	252	101	92	614	2.83	16,900	16,900	---	33,800
1958-59	274	99	98	632	2.92	20,700	18,400	---	39,100
1959-60	316	111	129	632	1.68	22,100	11,500	---	33,600
1960-61	327	105	126	729	1.13	22,700	8,100	---	30,800
1961-62	339	119	148	720	1.13	23,000	7,800	---	30,800
1962-63	357	117	155	740	0.86	25,700	7,000	---	32,700
1963-64	367	123	167	704	0.72	26,100	4,900	---	31,000

residents of the district and is essential if the district is to continue to grow.

The condition of the existing distribution system is a less critical problem but knowledge of it is necessary to determine the financial feasibility of the Ewing Project. The main portion of the distribution system was constructed in 1953, and additions and extensions have been made each year since. The system now contains a variety of pipe sizes and materials. The main problem has been the leaking and breaking of pipes due to earth movements, freezing, and abrasion from large rocks in the backfill on lines along the state highway. The district has had poor service from its 4-inch asbestos-cement pipe due to freezing. Also there has been some trouble with negative pressures causing the rubber joint rings to draw back into the pipe, and with the service taps breaking out of the asbestos-cement pipe. The larger steel mains have been satisfactory but the 6-inch sizes are light gage and rust out quickly if the wrap is broken. Also some difficulty has been experienced with electrolysis on deadends.

Overall, the existing distribution system is not in dangerous condition, but it requires more than normal maintenance. It is likely that replacement will occur earlier than in a typical water distribution system.

History of Ewing Project

By 1958, the number of customers being served by the Trinity County Waterworks District No. 1 exceeded the distribution system design capacity of 250 connections. At about that time the district directors and local residents became interested in securing an additional source of municipal water. The Agricultural Extension Service had prepared a report in 1944 for a potential dam and reservoir project on Hayfork Creek about 1 mile upstream from the floor of Hayfork Valley. The Department of Water Resources described essentially the same project in Bulletin No. 3, "The California Water Plan", and termed it the Layman Project.

The district contacted the Department of Water Resources in 1959 and expressed interest in obtaining assistance under the Davis-Grunsky Act for construction of an irrigation and municipal water supply project at the Layman site. The Department made cursory studies of the project and informed the district that water costs would be quite high, but suggested that the district was welcome to submit a request for preliminary determination of eligibility

for assistance under the Davis-Grunsky Act. Such a request was submitted in 1960 for a $1,250,000 Layman Project, and the district was found to meet the conditions of eligibility.

By early 1962, the district had decided that the Layman Project was too ambitious at that time and began considering smaller projects, for domestic supply only. The district requested that the Department hold their application on file. Later in 1962, a meeting was held in Hayfork by the United States Area Redevelopment Agency to discuss a water project for the area. At that meeting, the government representatives said that it might be possible to obtain grants to pay for 75 percent of the Layman Project, but that a feasibility report would be required. Immediately, the district requested the Department to reactivate its application for assistance under the Davis-Grunsky Act and decided to submit a request for a $25,000 loan for a feasibility report on the Layman Project.

In February 1963, the district was ready to submit its formal loan request. Assemblywoman Pauline L. Davis met with the district directors and department representatives and pointed out the dangers of overloading the district with debt and suggested that a smaller project be considered which would take care of the immediate municipal water supply problem. Mrs. Davis asked the district to retain its loan request and requested the Department to estimate the cost of a reconnaissance study of a small municipal water supply project. In the latter part of February 1963, the Department conducted a brief survey of possible projects to supply municipal water to Hayfork. The Department concluded that an off-stream storage project in Ewing Gulch was the most promising and estimated that such a project would cost about $750,000. A reconnaissance study was estimated to cost $7,000 for the Ewing Project.

The Legislature in 1963 authorized the Department to make a reconnaissance study of the Ewing Project. The study was begun in August 1963, and completed, as scheduled, in June 1964. A report on the study was published at that time. A budget augmentation of $2,700 was required for completion of the reconnaissance study, bringing the total cost to $9,700. The report concluded that the Ewing Project was engineeringly feasible and economically justified and that no other project was found which would meet the needs of the district at lower cost. The report recommended that the project be considered by local interests for a feasibility study.

In 1964, the Legislature directed the Department to conduct a one-year feasibility study of the Ewing Project, to be completed by June 1965. A total of $45,000 was provided for the study. This bulletin reports on the results of the feasibility study.

CHAPTER III. EWING PROJECT PLANNING STUDIES

This chapter describes the planning studies made to determine the physical arrangement and size of the various features of the Ewing Project, the proposed method of operation of the project, and the potential of Ewing Reservoir for fishing and other recreation use.

Ewing Project Description

The Ewing Project, as proposed, would consist of a dam and reservoir on Ewing Gulch, diversion facilities to convey excess flows from Big Creek to the reservoir, and a pumping plant to lift water to a treatment plant adjacent to the district's existing regulation reservoir. The project would be sized to meet estimated water demands for the next 30 years, and provision would be included for future enlargement. A layout of the project is shown on Plate 1.

The diversion from Big Creek would be made at an existing low concrete diversion dam about 2.5 miles northeast of Ewing damsite. The diversion dam is currently used for irrigation of Big Creek Ranch. An unlined canal about 12,000 feet in length would convey up to 10 cubic feet per second to a low divide separating the Big Creek and Ewing Gulch drainage basins. Since the canal would generally follow an existing irrigation ditch used by Big Creek Ranch, arrangements would be made for the ranch to use the new canal during the irrigation season. From the low divide, water from Big Creek would flow down a natural drainage channel to Ewing Reservoir.

Ewing Reservoir would be formed by an earthfill dam about 60 feet in height. The reservoir, at its normal water surface elevation of 2,428 feet, would contain 820 acre-feet and would have a surface area of 42 acres. An uncontrolled overflow spillway would be provided on the right dam abutment. The dam would be constructed of dredger tailings from the area of Hayfork Creek and clay soils from the reservoir. Provision would be included in the dam design to permit future enlargement.

The pumping plant at the toe of the dam would house two 30-horsepower pumps to lift water 150 to 180 feet to the treatment plant near the existing district regulation reservoir. The treatment plant would incorporate facilities for complete water treatment including coagulation, sedimentation, filtration,

and disinfection. Treatment facilities would be constructed with an initial capacity of 0.8 million gallons per day (MGD) and enlarged to 1.6 MGD in approximately 10 years.

Project Purposes Considered

In addition to the primary project purpose of municipal water supply, consideration was given to other items which might be included as project purposes. These other possible purposes were irrigation, fisheries enhancement, and recreation.

If the Ewing Project were sized for future municipal water demands, some surplus water would be available during the early years of operation. Consideration was given to interim sale of this extra water for irrigation use in Hayfork Valley. It was found that the market for such water would be extremely limited since existing water supplies are generally adequate for the small acreages of land under irrigation. Also, since the main crops within the potential service area are pasture, alfalfa, and hay, the payment capacity would not be enough to pay the water costs. Therefore it was concluded that it would not be economically justified to enlarge the project to provide for irrigation use.

Studies of the recreation potential of Ewing Reservoir were made by the Departments of Fish and Game and Parks and Recreation. These studies showed that inclusion of recreation, primarily fishing, was justified as a project purpose. These studies are described more fully later in this chapter.

Sizing Studies

Selection of the optimum size for Ewing Reservoir required a determination of future water demands, derivation of the relationship between reservoir size and yield, and studies to determine the project size resulting in the maximum excess of benefits over costs.

Future Water Demands

The 1960 population of Hayfork Valley was about 2,050 of which some 1,250 were classified as urban residents. Population projections for hydrographic units and subunits of various North Coastal basins were prepared under the Department's Coordinated Statewide Planning Program. These projections indicate an increase in the total population of Trinity County from 9,000 in

1960 to 25,000 in 2020. They are broken down further to show an urban population of Hayfork Valley of 4,200 in 2020. These population figures were used as the basis for estimating future water demands of the Trinity County Waterworks District No. 1. The 50-year period of analysis was selected for the years 1967 to 2017 to correspond to the most likely time of construction of the Ewing Project. The population figure for 1967 was adjusted to the 1964 population since recent water sales records indicate little change in the number of services from 1963 to 1964. This may indicate that the present water system is beginning to restrict growth.

At present, about 85 percent of the urban population of Hayfork Valley is served by the district. It was assumed that the district would serve 95 percent of the urban population of Hayfork Valley after 1977. The number of persons served by the district is shown in Table 2.

Studies and projections of unit urban water use in the Trinity River Hydrographic Unit were also prepared as a part of the Coordinated Statewide Planning Program. Average daily per capita water use throughout the Hydrographic Unit was estimated at 200 gallons in 1960, 225 gallons in 1990, and 250 gallons by 2020. However, the 1964 urban water demand in the district service area was only about 120 gallons per capita per day (gpcpd). Present use in the district is undoubtedly limited to some extent by the relatively high cost of water and the potential deficiencies of the present supply. These factors were considered in predicting future unit water use in the district service area. It was estimated that the unit water use would increase immediately to 150 gpcpd when a new supply was made available. Unit water use in 2017 was estimated at 225 gpcpd, about 10 percent lower than the average for the Hydrographic Unit, due to the relatively high cost of water. These water requirements are based on the permanent population served and include water used by ordinary business and commercial firms. Industrial uses and distribution losses are not included.

Table 2 presents the total projected water demands for the district. An allowance of about 10 percent of the delivered water was made for losses and leakage from the distribution system and regulation reservoir. The projected total number of domestic services, based on an average of 3.5 persons per service, is also shown in Table 2. The projected number of business and commercial connections was assumed to increase in direct proportion to the increase in population.

TABLE 2

PROJECTED WATER DEMANDS FOR TRINITY COUNTY WATERWORKS DISTRICT NO. 1

	Year					
	1967	1977	1987	1997	2007	2017
Projected urban population of Hayfork Valley	1,470	2,190	2,830	3,350	3,780	4,100
Percent served	85	95	95	95	95	95
Projected population served by T.C.W.D. No. 1	1,250	2,080	2,690	3,190	3,600	3,900
Demand -- gpcpd	150	170	185	200	215	225
Annual demand -- acre-feet						
Deliveries	210	400	560	720	870	980
Losses	20	40	60	70	90	100
Total	230	440	620	790	960	1,080
Number of services						
Domestic	357	595	768	912	1,030	1,120
Commercial	20	33	43	51	60	60
Total	377	628	811	963	1,090	1,180

No allowances were made for industrial use in the water requirement projections. Projections were made of Hayfork Valley industrial use as a part of the Coordinated Statewide Planning Program; the principal projected industrial development centered around lumbering and processing of wood products and production of sand and gravel for local requirements. The annual industrial water demand in Hayfork Valley was estimated to increase from 180 acre-feet in 1960 to 210 acre-feet by 2020. Since the present industrial users are not supplied with treated domestic water, it was assumed that future increases in demand would be met through surface diversions or limited ground water development. However, it should be noted that the Ewing Project would have an excess supply capacity during the early years of project operation so that industries desiring interim service could be accommodated. This water could be supplied without having to be treated, so water costs would not be prohibitive. The effect of such a development would be to hasten construction of future system additions.

Ewing Reservoir Storage Versus Yield

Studies were made to define the relationship between the size of Ewing Reservoir and the yield which could be obtained from it. The following paragraphs describe the methods used and results obtained from the storage-yield study.

Yield from Ewing Reservoir was assumed to be withdrawn on the following municipal demand schedule, which was derived from district records of water deliveries for the period from 1958-59 through 1963-64.

Month	Percent of Annual Demand	Month	Percent of Annual Demand
October	7	April	6
November	5	May	7
December	4	June	14
January	4	July	16
February	4	August	15
March	4	September	14

The average annual natural inflow to Ewing Reservoir was estimated to be about 500 acre-feet. However, runoff during critical dry periods would be so small that it would have little effect on the yield of the reservoir.

The amount of water which could be diverted to Ewing Reservoir from Big Creek with various canal capacities was based on study of the records of daily flow at the Big Creek gaging station. Curves were prepared which related the possible monthly diversion with various canal capacities to the monthly runoff at the diversion dam. Based on the ratio of drainage areas, monthly runoff at the diversion point was calculated as about 88 percent of the estimated runoff at the gaging station. It was assumed that a minimum of 2 cubic feet per second would be released at all times for fish maintenance. Most diversions would be made during the nonirrigation season from October through March, but for those late spring months when flows in Big Creek were higher than required for irrigation and fish maintenance, it was assumed that up to 5 cubic feet per second could be diverted to Ewing Reservoir whenever the remaining flow exceeded 15 cubic feet per second. This would assure sufficient flow for maintenance of the present steelhead population.

Based on the above conditions of operation, and annual reservoir evaporation of 3.5 feet, the storage-yield relationship was investigated for

various diversion capacities. Figure 1 shows the resulting relationship between the size of Ewing Reservoir, capacity of the diversion from Big Creek, and the resulting possible safe annual yield on a municipal demand schedule.

The dates on the storage-yield curves of Figure 1 show the critical periods of historical runoff which would have controlled the reservoir yield. As long as the diversion is large enough to not limit the yield, the worst critical period is only seven months long. This indicates that the reservoir would function essentially to store water in the spring and early summer for use during the late summer and fall. There is therefore no need for long-term storage to survive long dry periods covering more than one season.

Selection of Optimum Project Size

It is the policy of the Department to size projects so as to maximize the excess of economic benefits over economic costs. This policy was followed in the sizing studies of the Ewing Project. Benefits and costs were evaluated on the basis of present worth for a 50-year period of analysis. An interest rate of 4 percent was used to discount future benefits and costs.

The benefits from the supply of municipal water to the district were first evaluated for future conditions without construction of an additional water supply project. Benefits were then evaluated for the 50-year period with the Ewing Project constructed. The increase in benefits was attributed to the project. Future costs to the district and its customers were similarly evaluated under project and nonproject conditions. A complete description of the methods and assumptions used in analyzing benefits and costs for the selected project is presented in Chapter V. Essentially the same procedures were used in the sizing studies.

Total benefits and costs were evaluated for six sizes of the Ewing Project. These sizes were selected to meet the projected water demands for each decade from 1967 through 2017. The excess of benefits over costs was calculated for each of the six project sizes, and it was found that maximum net benefits would result from a project sized for the projected demands for the year 1997, the thirtieth year of the analysis.

The projected annual water demands for the year 1997 are 790 acre-feet. From the storage-yield curves, Figure 1, the required active storage

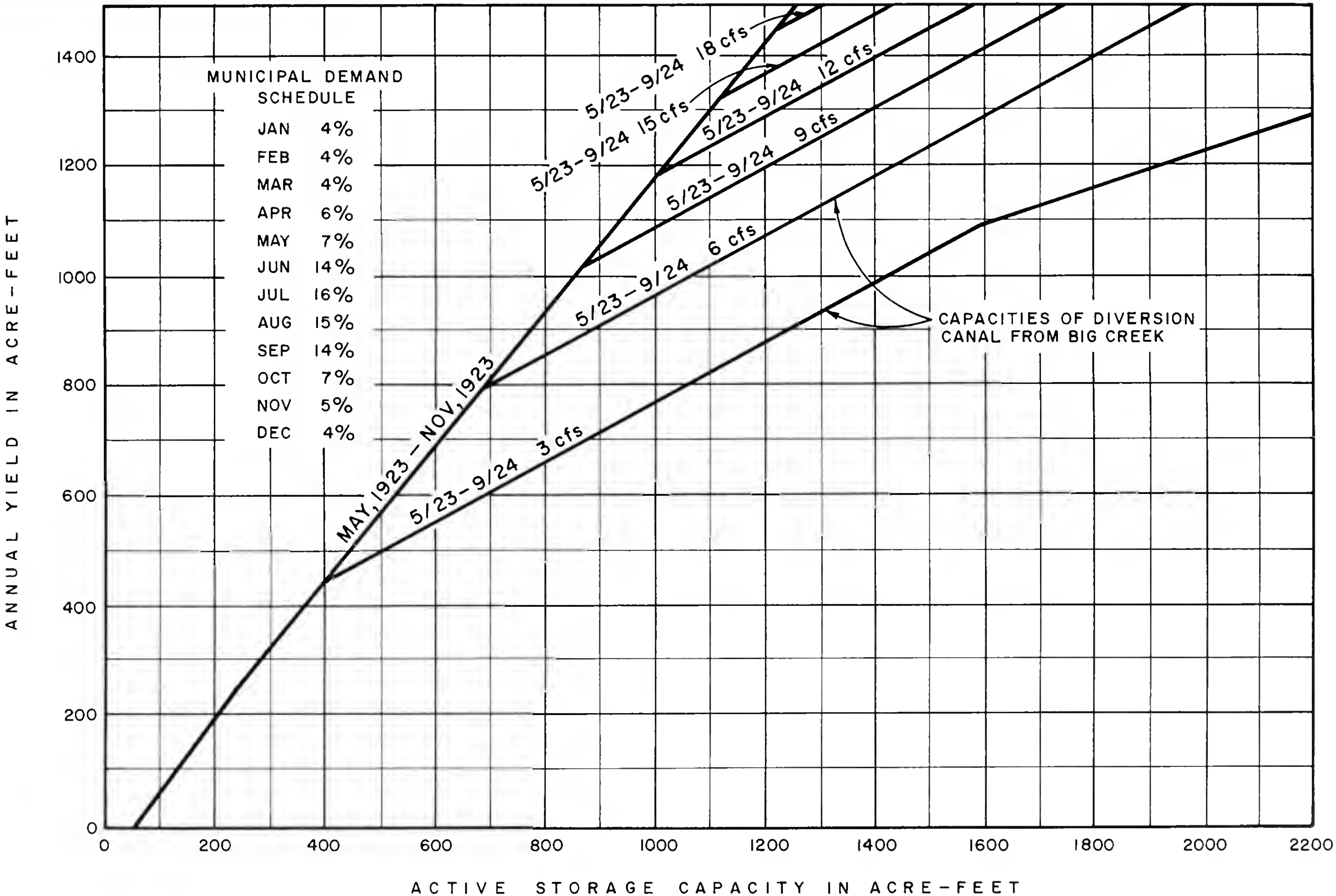


Figure I. YIELD OF EWING RESERVOIR VERSUS ACTIVE STORAGE CAPACITY

capacity of Ewing Reservoir is 680 acre-feet with a minimum capacity of the diversion from Big Creek of 6 cubic feet per second. The gross storage capacity of the reservoir was established as 820 acre-feet to allow for the inactive storage below the minimum pool elevation. A diversion capacity of 10 cubic feet per second was selected to provide operational flexibility.

Proposed Project Operation

It is proposed that Ewing Reservoir be constructed to a size sufficient to meet the projected water demand for the year 1997. During the early years of operation only a small part of the capacity would be used, so the reservoir would be maintained relatively full throughout the year. Then, as demands increase, the reservoir would be drawn down farther each year. To evaluate the recreation potential of the reservoir, examination was made of the effects varying water conditions would have on the reservoir.

Figure 2 shows the maximum reservoir drawdown which could occur in any particular year of project operation, assuming that the most severe historic runoff conditions occurred each year. The maximum drawdown represented by this figure would occur only about twice during the 50-year period of operation. Also shown on Figure 2 is the typical maximum drawdown for the various years of operation, assuming median water supply conditions and operation of the reservoir to maintain the maximum possible storage.

Figure 3 shows the manner in which the reservoir water surface would vary throughout the year. It was first assumed that the reservoir would be filled during the winter months and that no diversion would be made from April through October. This would be a very casual reservoir operation in which the only criterion would be to have the reservoir full on April 1. The resulting annual variation in reservoir water surface elevation is shown in Figure 3A for various years of operation. In this operation the reservoir would be drawn down rapidly each summer, reaching, in every year, the lowest possible level indicated by Figure 2. Although this method of operation would not reduce the reservoir yield, it would obviously be undesirable for recreation.

Ewing Reservoir could also be operated in a manner that would keep it as full as possible at all times. Thus, water would be diverted from Big Creek whenever it was available and whenever the reservoir was not full. This method of operation would have the advantage of diluting Ewing Gulch runoff with larger amounts of higher quality water from Big Creek. It would also

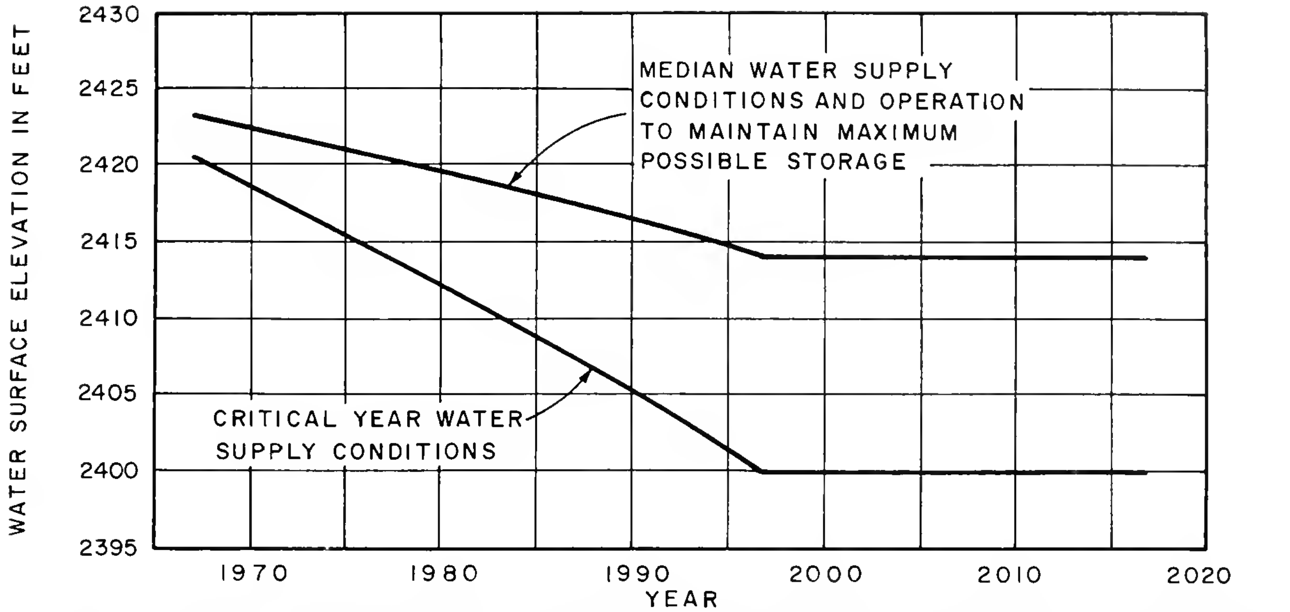


Figure 2. EWING RESERVOIR MINIMUM WATER SURFACE ELEVATION

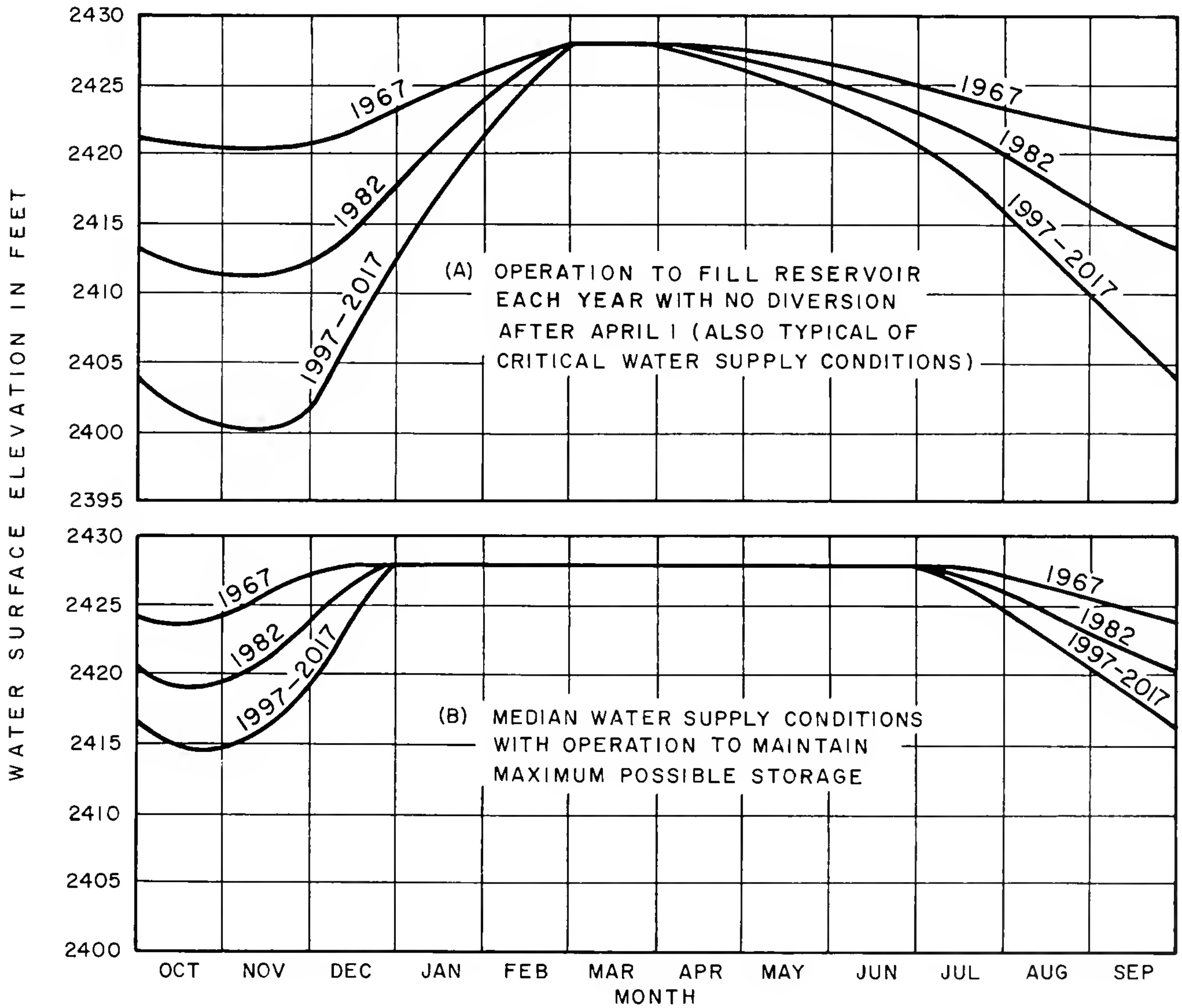


Figure 3. EWING RESERVOIR ANNUAL WATER SURFACE ELEVATION

greatly reduce the average annual drawdown of the reservoir. Figure 3B shows the typical annual variation in water surface elevation with Ewing Reservoir operated to maintain the maximum possible storage. Curves for the various years of operation were based on median values of the monthly runoff of Ewing Gulch and Big Creek. Therefore, if the reservoir were operated to maintain the maximum possible storage, the levels indicated in Figure 3B would be exceeded in about half the years of operation and would not be attained in the other half. Since this method of operation is the most desirable from the standpoints of water quality, costs, and recreation use, it is proposed that Ewing Reservoir be operated in this fashion. However, diversion from Big Creek would be stopped when the water was turbid or muddy from storm runoff. This reservation would result in somewhat slower filling of the reservoir during the winter but would not affect reservoir levels during the remainder of the year.

A monthly operation study of Ewing Reservoir was conducted using the runoff of the critical historical period in 1923 to demonstrate that a yield of 790 acre-feet per year, corresponding to the projected 1997 demand, could be obtained. This operation is shown in Table 3.

Fisheries Enhancement and Recreation Studies

During the 1963 reconnaissance study of the Ewing Project, consideration was given to inclusion of recreation as a project purpose. At that time, the projected recreation use was based on provision of facilities for water-associated recreation, including picnicking, fishing, and swimming. It was found that the cost of required facilities for recreation would exceed estimated benefits, and it was therefore concluded that inclusion of recreation as a project purpose was not economically justified.

Additional study of the recreation potential of the Ewing Project was performed as a part of this feasibility study. Under a contract agreement with the Department of Water Resources, the Department of Parks and Recreation prepared more detailed studies of the origin of potential recreationists at the Ewing Project, assuming again that water-contact recreation would be permitted. Using the methods of the Department of Water Resources for evaluating benefits due to recreation use, it was again concluded that provision of facilities for water-contact recreation would not be economically justified. Therefore, all subsequent study was directed toward nonwater-contact recreation

TABLE 3

EWING RESERVOIR OPERATIONS FOR 1922-24 WITH PROJECTED 1997 DEMAND
(Flows in Acre-feet)

Month	Big Creek			Natural Runoff to Ewing Res.	Ewing Reservoir				
	Flow at Diversion Point	Maximum Allowable Diversion to Ewing	Diversion to Ewing		Total Inflow	Urban Demand	Evaporation	Spill	End-of-month Storage
Oct. 1922	90	30	0	0	0	50	0	0	120
Nov.	260	190	100	10	110	40	0	0	190
Dec.	1,580	560	280	30	310	30	0	0	470
Jan. 1923	2,820	600	300	60	360	30	0	0	800
Feb.	1,500	550	20	30	50	30	0	0	820
Mar.	700	380	30	10	40	30	10	0	820
Apr.	2,820	300	0	60	60	50	10	0	820
May	530	0	0	10	10	60	20	0	750
June	350	0	0	10	10	110	20	0	630
July	180	0	0	0	0	130	20	0	480
August	90	0	0	0	0	120	10	0	350
Sept.	90	0	0	0	0	110	10	0	230
Totals	11,010	2,610	730	220	950	790	100	0	
Oct. 1923	90	30	0	0	0	50	0	0	180
Nov.	0	0	0	0	0	40	0	0	140
Dec.	180	120	60	0	60	30	0	0	170
Jan. 1924	530	320	240	10	250	30	0	0	390
Feb.	1,930	580	420	40	460	30	0	0	820
Mar.	260	190	30	10	40	30	10	0	820
Apr.	180	0	0	0	0	50	10	0	760
May	90	0	0	0	0	60	20	0	680
June	0	0	0	0	0	110	20	0	550
July	0	0	0	0	0	130	20	0	400
August	0	0	0	0	0	120	10	0	270
Sept.	0	0	0	0	0	110	10	0	150
Totals	3,260	1,240	750	60	810	790	100	0	
Oct.	350	270	140	10	150	50	0	0	250
Nov.	2,200	600	300	50	350	40	0	0	560
Dec.	2,550	600	240	50	290	30	0	0	820

use of Ewing Reservoir, which would consist primarily of fishing and associated day-use.

Also under the terms of a contract agreement with the Department of Water Resources, the Department of Fish and Game evaluated the potential fish production and angling capacity of Ewing Reservoir. It was concluded that Ewing Reservoir would have a fairly good potential for warm-water fish production, if (1) the reservoir were operated to maintain the water surface at as high a level as possible, and (2) copper sulphate treatments for control of algae in the reservoir were applied judiciously with careful attention to the need for protecting fish. The best species of fish for Ewing Reservoir were thought to be largemouth bass and red-ear sunfish; summer water temperatures would probably be too high for trout. The initial cost of stocking the reservoir was estimated at about $200.

The Department of Fish and Game estimated that, under the conditions described above, Ewing Reservoir could support an initial annual fishing use of about 2,200 angler-days. Due to the increasing annual drawdown of Ewing Reservoir with increasing water demands, the fish production of the reservoir was estimated to gradually decrease until only about 800 angler-days could be supported by the project when it was operated to its full design capacity.

Additional studies were made by the Department of Parks and Recreation in which projections were made of the origin and the total number of recreationists (primarily anglers) under conditions of nonwater-contact use. These projections took into account both the projected future increase of individual participation in outdoor recreational activities and the growth in the number of local residents. The projected total numbers of users under these conditions were considerably smaller than those estimated for the reconnaissance study, which were based on the inclusion of all types of water-contact recreation. However, origin-of-use studies showed that visitors attracted to the project for fishing would tend to be drawn from greater distances than those attracted for other types of recreation. This resulted in a considerably greater benefit per visitor-day for fishing use. Since far fewer facilities would be required for this type of use, and since considerably greater net benefits would be realized, it was found that nonwater-contact recreation use of Ewing Reservoir would be economically justified. The estimated total annual fishing and recreation use at Ewing Reservoir was derived from estimates furnished by both the Department of Fish and Game and the Department of Parks and Recreation as follows:

Year	Total Visitor-days
1967	2,200
1977	2,300
1987	2,500
1997	3,200
2007	4,300
2017	5,300

The total present worth of fisheries enhancement and recreation benefits at Ewing Reservoir, as described in Chapter V, was found to be $120,000; whereas the present worth of capital and annual costs for recreation facilities described in Chapters IV and V was estimated at $19,000.

CHAPTER IV. EWING PROJECT DESIGN AND COST ESTIMATE

The Ewing Project would consist of a dam and reservoir in Ewing Gulch northeast of Hayfork, diversion and conveyance facilities to transport water from Big Creek to Ewing Gulch, and pumping and water treatment facilities to deliver yield from the project to the existing regulation reservoir of Trinity County Waterworks District No. 1.

The optimum plan for development, as determined from the sizing studies, would include Ewing Reservoir with a gross storage capacity of 820 acre-feet and a canal from Big Creek with a capacity of 10 cubic feet per second. As demand increased, additional yield could probably be obtained most economically by enlargement of Ewing Reservoir; therefore provisions were included for eventual enlargement. It was estimated that this enlargement would be required in about 30 years. However, this feasibility study was confined to the initial phase of construction.

This chapter describes the field investigations and design studies performed during this feasibility study, and includes pertinent information from the 1963-64 reconnaissance study. The proposed designs for the various project features are described and an itemized estimate of all project costs is included.

Basic Data Collection

Before detailed design of the project features was begun, field investigations were conducted to assemble the necessary data. These field studies and their results are described in the following paragraphs.

Mapping

Maps of Ewing damsite, the reservoir area, and the diversion route from Big Creek were prepared by photogrammetric means. The damsite map was prepared at a scale of 1" = 150' with a 5-foot contour interval; the remainder of the mapping was at 1" = 300' with a 10-foot contour interval. All maps are suitable for use in preparation of final plans and specifications for project construction.

Geology

Initial geologic studies of Ewing damsite and reservoir area were performed during the 1963 reconnaissance investigation. Additional, more detailed studies were carried out during this feasibility investigation. An office report was prepared for each portion of the geologic investigation program. The following paragraphs describe the studies which were made and summarize the results and conclusions presented in the geology office report.

Areal Geology. Ewing dam and reservoir sites are located in the northern portion of Hayfork Valley, an area underlain and surrounded by a thick sequence of sedimentary beds collectively known as the Weaverville formation. This formation underlies practically all of the valley floor and the adjacent low hills. In Hayfork Valley the formation is made up of a very compact and hard clay, silt, sand, and gravel. Where these materials are more consolidated and exhibit pronounced stratification, they have been described as shales, sandstones, and conglomerates. However, in the vicinity of Ewing damsite and reservoir, stratification or bedding is not apparent, and no true shale, sandstone, or conglomerate beds are known to be present. The Weaverville formation, believed to be of Oligocene age, has been preserved in Hayfork Valley by downfaulting into a much older sequence of hard, consolidated rocks which form the high mountains surrounding the valley. In general, the beds are nearly flat lying, but in the northern portion of the valley they dip southward and southeastward at angles up to 30 degrees from the horizontal. Maximum thickness of the formation is believed to be about 2,000 feet. The thickness in the Ewing Gulch area, although not known precisely, is probably much less than 2,000 feet.

Ewing Damsite Geology. The foundation of Ewing damsite is made up of various compact sediments consisting of clay, sandy and silty clay, and gravelly sandy clay. Exposures of these sediments in the vicinity of the site are very scarce due to a thick soil and slopewash cover; consequently, little is known of the geological structure. However, it is believed that the beds dip to the southeast at a shallow to moderate angle, and strike parallel to Ewing Gulch. The ridges southeast of the site are elongated in a northeast-southwest direction and appear to be structurally controlled by the trend of the bedding.

Subsurface exploration conducted during the reconnaissance phase of the investigation in September and October 1963 consisted of excavating trenches

with a tractor-mounted backhoe and drilling auger holes with a truck-mounted auger. Along the axis of the proposed dam seven trenches were dug to a maximum depth of 9 feet and seven auger holes were drilled to a maximum depth of 25 feet. The feasibility phase of subsurface exploration was conducted during July and August 1964. A trench was excavated to a depth of about 15 feet across the channel at the proposed axis. Two core holes were drilled in the channel and one was drilled on each abutment; the aggregate depth of all core holes was about 425 feet. The location of these core holes is shown on Plate 3.

The right abutment has a uniform slope of about 33 percent to a height of about 75 feet above streambed. Two auger holes and several trenches were dug on the right abutment. The soil and slopewash overburden extend to a depth of about 3 feet, below which the sediments become quite hard and difficult to excavate. The auger holes encountered clays, sandy silts, and gravelly clays. A 3-inch core hole was drilled 157 feet vertically into the right abutment from a point near the proposed dam crest. The core recovered consisted of clay, silt, sand, gravel, and cemented gravel in various mixtures; the most common material was a tight, hard, grayish-blue silty clay. About 80 percent of the core was recovered. Some of the gravel, especially from about 57 to 67 feet, seemed fairly clean; the remainder of the gravels are probably mixed with clay. Stripping of approximately 3 feet of soil and root zone from the right abutment would expose a weathered but firm surface suitable as a foundation for placement of fill. Further excavation would not materially improve foundation conditions.

The left abutment has a slope of about 25 percent and is more irregular than the right abutment. Several small terrace-like levels occur near the proposed dam axis. These appear to be a series of old slumps which are probably shallow and confined to the relatively thin soil cover. Due to problems of access, no auger holes were excavated in the left abutment near the axis during the 1963 reconnaissance exploration program. However, two auger holes were drilled in the ravine just upstream; these encountered clay, silt, sand, and gravel mixtures to depths of about 25 feet. A trench was dug near the proposed dam axis to a depth of 6 feet in silt and clayey silt with sand. A 3-inch core hole was drilled 155 feet vertically into the left abutment from a point about 5 feet below the proposed dam crest. About 85 percent of the core was recovered; it was essentially the same as the material

encountered in the right abutment core hole. However, carbonaceous material in a matrix of fine sand was cored at a depth of 147 feet. Stripping of about 5 feet of soil and root zone from the left abutment would expose a weathered but firm surface suitable as a foundation for replacement of fill.

The channel section at Ewing damsite is approximately 150 feet wide and filled with 3 to 7 feet of loose, gravelly clays and silts. Beneath this alluvial cover are compact sediments of the Weaverville formation. An auger hole in the center of the channel section was drilled to a depth of 25 feet in very hard clay or silty clay. Similar material was encountered in an auger hole at the base of the right abutment, where drilling was stopped at a depth of 20 feet due to extreme hardness and a slow drilling rate. A third auger hole, drilled to a depth of about 25 feet near the base of the left abutment, encountered mostly a gravelly clay below about 3 feet of alluvium. In July 1964, a trench was excavated across the channel section along the proposed dam axis. Channel deposits were about 3 feet in thickness except at the base of the right abutment where the clayey sandy gravels were at least 5 feet thick. The trench was dozed and ripped to a maximum depth of 15 feet through brown, clayey silt which graded downward into harder gray clayey siltstone. Two 3-inch core holes were drilled to depths of about 55 feet in the channel section, one upstream and one downstream of the trench. The upstream hole encountered considerably more gravel than expected from observation of the trench excavation and only 57 percent of the core was recovered. A second hole was then drilled downstream from the trench; the upper 15 feet of that hole encountered materials similar to those found in the trench and the remainder of the hole passed through gravelly and silty clays. It was concluded that the difference in materials from the two core holes was probably due to channelization although caving in the upstream hole might have caused some misinterpretation in the amount of gravel logged.

When auger drilling was completed, field permeability tests were conducted on three of the holes. The highest indicated permeability coefficient was about 20 feet per year, measured in the gravelly hole in the channel section. Other tests indicated lower permeability. Percolation rates in other auger holes and three of the core holes were quite low, and it was concluded that the Weaverville formation is quite impervious and that leakage would not be a problem.

Spillway Geology. The right abutment would be the most suitable location for the spillway at Ewing damsite. No auger holes or trenches were placed directly on the spillway alignment, but nearby exploration revealed a very dry, hard, silty, sandy, gravelly clay, believed to represent an old terrace deposit. Spillway cuts near the dam crest would be partially in gravelly clay and in a more clayey deposit of the underlying Weaverville formation. Cut slopes should be fairly flat. Because of the erosive nature of the formation, the entire spillway should be lined.

Reservoir Geology. The entire reservoir is underlain by the Weaverville formation. Two auger holes were drilled in the west rim of the reservoir to evaluate possible leakage; it was concluded that leakage from the reservoir would be negligible. No mineral deposits of commercial value are known to occur in the reservoir.

Soils Testing. A limited program of laboratory soils testing was carried out in conjunction with the geologic exploration of Ewing damsite. A summary of tests performed is presented in Table 4. All tests were conducted in accordance with Department testing procedures. Complete results of all tests are presented in an office report which describes the preparation of designs and cost estimates for the Ewing Project.

Seismicity. Seismic activity in this region is apparently only moderate. Exact locations or significance of individual faults is often uncertain. Earthquakes are generally not as frequent or severe as they are in most of the coast ranges in the areas south and west. Numerous earthquakes of Richter magnitude 6 and greater have occurred off the coastal area near Eureka. However, the nearest recorded earthquake to Hayfork Valley having a magnitude of 4 or greater was located some 20 miles west of Hayfork.

California has been divided into several seismic regions based on the expected maximum seismic intensities as measured on the Modified Mercalli Scale which varies from I (weak) to XII (extreme). The probable maximum regional intensity of the Hayfork area is VI. This value of VI assumes solid rock; locally on deep alluvial fills, or in this case the Weaverville formation, the probable maximum intensity could be higher. Therefore, moderate precautions should be taken to prevent damage to any structures placed in this area.

TABLE 4

SUMMARY OF LABORATORY SOIL TESTING PROGRAM

Note: All tests were conducted in accordance with standard testing procedures of the Department of Water Resources.

Test	Number	Results
A. Dam Foundation Material		
Mechanical and hydrometer analysis	10	Typically 65-99% silt and clay sizes
Specific gravity	5	2.73 to 2.84
Atterberg limits	6	Plasticity index: 22-41 Liquid limit: 44-68
In-situ dry density	8	94-112 Pcf (average 104)
In-situ moisture	8	18-28% (average 23)
Consolidation	1	1% at 4 Tsf
One-dimensional swell	1	0.2% at 3 PSI
Unconfined compression	1	0.86 Tsf maximum
Triaxial compression (CU)	1	Total stress: $\phi = 28^{\circ}$, C = 0 Effective stress: $\phi = 33^{\circ}$, C = 0
B. Impervious Borrow -- Reservoir Area		
Mechanical and hydrometer analysis	9	65-93% silt and clay sizes
Specific gravity	3	2.77-2.79
Atterberg limits	5	Plasticity index: 26-35 Liquid limit: 48-56
Compaction	2	106 Pcf @ 21% 114 Pcf @ 16%
Triaxial compression (CU)	1	Total stress: $\phi = 20^{\circ}$, C = 0 Effective stress: $\phi = 27^{\circ}$, C = 0
C. Impervious Borrow -- 300 Feet to 1,800 Feet Downstream From Damsite		
Mechanical and hydrometer analysis	5	Typically 83-91% silt and clay sizes
Specific gravity	1	2.77
D. Hayfork Creek Dredger Tailings		
Mechanical analysis	3	8-11% finer than No. 4 3% finer than No. 200

Construction Materials

Exploration for construction materials during the 1963 reconnaissance investigation was concentrated on impervious materials from the reservoir area where three auger holes and one dozer trench were excavated. Dredger tailings along Hayfork Creek about 1 mile from Ewing damsite were inspected. It was found that the reservoir area soils ranged from fat clays to sandy clays, but it was thought that additional exploration could locate more sandy or gravelly clays.

The materials investigation for the 1964 studies involved further exploration and testing of potential borrow areas within the reservoir area and downstream from the damsite, and gradation tests of the dredger tailings. Additional exploration for impervious material with 12 auger holes did not reveal any more sandy or gravelly areas, and it was concluded that the soil from the reservoir area would be most suitable and economical for the impervious core of Ewing Dam. The quantity of potential impervious borrow material within the reservoir is many times larger than the quantity required for Ewing Dam.

Field gradation tests were run on three large samples of the dredger tailings nearest to Ewing damsite. The samples were taken from near the surface of the tailing piles. Only about 10 percent of the sample material passed the No. 4 sieve; but it is expected that more fines would be encountered at greater depths. Based on a usable depth of 6 feet, some 300,000 cubic yards of dredger tailings are available in Section 12, T31N, R12W. Only about 96,000 cubic yards would be required for Ewing Dam. The proposed pervious borrow area is shown on Plate 1.

The Hayfork Creek dredger tailings would also provide suitable concrete aggregate, but processing would be required to obtain the proper gradation. All rocks appear sound and are not expected to be reactive.

A limited amount of laboratory testing was performed on samples of the potential construction materials. A summary of tests performed is presented in Table 4. Complete results of all tests are presented in an office report describing the preparation of designs and cost estimates for the Ewing Project.

Water Quality

Five samples of water were obtained from Big Creek near the present district diversion between 1958 and 1960 in connection with the Coordinated

Statewide Planning Program of the Department. Three more samples were obtained in 1963 during the reconnaissance investigation of the Ewing Project. Laboratory analyses of these eight samples formed the basis for judgment of the quality of Big Creek water.

As far as is known, no analyses had ever been made of the runoff of Ewing Gulch prior to the start of the reconnaissance study of the Ewing Project in 1963. Five samples of this runoff were obtained and analyzed in 1963 and one sample was obtained in 1964.

Table 5 presents a partial summary of data from laboratory tests of all samples from Big Creek and Ewing Gulch waters. Complete mineral analyses have been run on most of these samples and are available in the files of the Department of Water Resources.

Design Studies

Preliminary designs were prepared for the major features of the Ewing Project to establish the general form and layout of the project and to permit an estimate of construction costs. The proposed layouts and designs for each of the project features (summarized in Table 6) are described in the following sections.

Diversion Facilities

Flows of Big Creek in excess of irrigation and fish requirements would be diverted at an existing low concrete diversion dam located about $2\frac{1}{2}$ miles northeast of Ewing damsite. The diversion dam is currently used to serve an irrigation system for the Big Creek Ranch as shown on Plate 1. The actual diversion is made on the east bank of the creek, and a portion of the water is taken across the creek in a 3-foot semicircular metal flume to an irrigation system for the western portion of Big Creek Ranch. The flume invert is at an elevation of about 2,572 feet, some 32 feet above the low pass between the Big Creek and Ewing Gulch drainage areas.

It is proposed that diversions for the Ewing Project use the existing diversion headworks with only minor modifications to permit diversion during periods of high flow. The existing fish screen would be enlarged to a capacity of about 15 cfs, and the existing flume would be replaced due to its poor condition. From the downstream end of the flume, an unlined canal would be constructed along the route of an existing irrigation ditch for about

TABLE 5

ANALYSES OF BIG CREEK AND EWING GULCH WATERS

Source	Date Sampled	Temperature in ^{o}F	Specific Conductance in Micromhos @ 25^{o} C	PH	Parts Per Million					Organic Color Units
					Nitrate (NO_3)	Phosphate (PO_4)	Dissolved Oxygen	Total Dissolved Solids	Total Hardness as Ca CO_3	
Big Creek	6-8-58	54	205	8.0	0.1			122	100	
	5-19-59	53	214	7.9	0.1		10.2	125	102	
	9-2-59	70	251	8.0	0.8		8.9	148	121	
	3-15-60	42	175	7.8	0.2		10.8	103	85	
	9-30-60	60	257	8.2	0.2		7.9	149	123	
	3-26-63		207		0.2				104	
	11-10-63	50	201	8.3	3.7	0.10			102	
	11-16-63	40	201	7.9	0.2	0.02			96	
Ewing Gulch	3-26-63		35	7.5	0.0	0.15		31	13	
	6-20-63		93	7.5	3.2	1.0		82	37	
	11-11-63		37	6.7	0.1	0.16			12	60
	11-16-63		39	6.6	0.2	0.16			13	70
	11-16-63		41	6.9	0.4	0.22			16	70
	12-7-64		36	7.2	0.4	0.11		40	14	30

TABLE 6

FEATURES OF EWING PROJECT

Reservoir	
Drainage area in square miles	0.6
Water surface elevation, in feet, USGS datum	
Maximum	2,432
Normal	2,428
Minimum	2,400
Storage capacity at normal water surface, in acre-feet	820
Reservoir area at normal water surface, in acres	42
Dam	
Location	$SE\frac{1}{4}$ of $SE\frac{1}{4}$, Section 1, T31N, R12W, MDB&M
Type	Earthfill
Crest elevation, in feet, USGS datum	2,435
Height of dam above streambed, in feet	60
Crest length, in feet	550
Crest width, in feet	20
Total embankment, in cubic yards	142,000
Spillway	
Type	Ogee
Crest elevation, in feet, USGS datum	2,428
Crest length, in feet	10
Design flood surcharge head, in feet	3.5
Design flood residual freeboard, in feet	3.5
Design capacity, in second-feet	260
Energy dissipator	Stilling basin
Outlet Works	
Type	Cut and cover
Diameter, in inches	24
Pumping Plant	
Plant elevation, in feet, USGS datum	2,395
Installed capacity, horsepower, initial	60
Discharge pipe diameter, in inches	12
Static pumping head	
Minimum	175
Maximum	147
Diversion Facilities	
Location of diversion dam	$SW\frac{1}{4}$ of $SE\frac{1}{4}$, Section 30, T32N, R11W, MDB&M
Stream	Big Creek
Elevation of diversion dam, in feet, USGS datum	2,576
Elevation of saddle to Ewing Gulch	2,540
Capacity of canal, in cubic feet per second	10
Length of canal, in feet	12,000

4,000 feet. A final 8,000 feet of canal would generally follow the route of an unused portion of the irrigation ditch. The diversion canal, shown on Plate 2, would have a bottom width of 3 feet, 1.5:1 side slopes, and a grade of 0.0032.

The canal would be located entirely on clay soils so leakage should not be a problem. The terrain is gentle for the upper two-thirds of the canal's length, but the lower portions will pass through areas having cross slopes as great as 60 percent.

The canal would be used by the Big Creek Ranch during the irrigation season as a replacement for the existing works. It was assumed that the cost of right-of-way and of relocating existing turnouts would be borne by Big Creek Ranch since the canal would represent a substantial improvement over the existing ditches.

Timber bridges would be provided over the canal at key locations for use of cattle and ranch machinery. Timber flumes would be provided at points of major cross-drainage to reduce damage and to prevent pollution of Ewing Reservoir. Barbed-wire fencing would be installed along the entire canal route to prevent damage to the canal and pollution of the water by cattle.

A 24-inch-diameter inverted siphon about 120 feet long would be required to cross a small draw near the lower end of the canal. The canal would cross the drainage divide into Ewing Gulch at an elevation of about 2,533 feet, requiring a cut of about 7 feet below the existing ground surface.

Ewing Dam

The Ewing Project would meet the estimated water requirements of the district for about 30 years. At that time, the most economical source of additional water would probably be an enlargement of Ewing Reservoir. Accordingly, it was decided that the design of Ewing Dam should be suitable for eventual enlargement. The dam was designed to accommodate an increase in height of about 12 feet, which would provide a yield in excess of the estimated water demands for the year 2020.

Since the only readily available construction materials for Ewing Dam are clays in the vicinity of the damsite and dredger tailings along Hayfork Creek, the problem of selection of a dam section was mainly concerned with arrangement of these materials. The two main types of design considered were (1) a homogeneous impervious dam section with internal drainage zones, and

(2) a central core gravel-fill section. The central core section with gravel-fill was adopted for the following reasons:

1. It would be less expensive due to a somewhat smaller volume.

2. It is better adapted to future enlargement than an impervious section with slope protection on both slopes and a chimney drain system.

3. It would be easier to construct because a narrow chimney drain would not be needed. Also, by reducing the amount of impervious fill, the problem of obtaining water for embankment moisture control would be reduced. (There is flow in Ewing Gulch only during the winter.)

The normal water surface of Ewing Reservoir would be at an elevation of 2,428 feet. Spillway flood routing studies showed that the maximum depth of flow over the spillway would be about 3.5 feet under probable maximum flood conditions; the dam crest would be placed at an elevation of 2,435 feet to provide safety against overtopping during severe flood conditions. The dam would thus be about 60 feet in height above the existing ground surface.

The dam crest width was established at 20 feet to provide for limited vehicular travel. The width of the top of the impervious core was also established as 20 feet to provide a good base for future increases in height. Minimum transition section widths of 8 feet were selected since the transition material would be expensive.

Foundation treatment for Ewing Dam would consist mainly of removal of weathered soil and root zone materials from the surface of the foundation. Stripping estimates were based on the geology report, which recommended removal of 5 feet on the left abutment, 6 feet in the channel section, and 3 feet on the right abutment. Provision was included for a shallow cutoff trench to an additional depth of 3 feet on the abutments and 10 feet in the channel section. The cutoff in the channel section would have to extend below the area which was disturbed by the exploration trench excavated in July 1964.

The selected design for Ewing Dam is shown on Plate 3. The dam section was designed by the standard method of slices. Table 7 compares the material properties used in the dam stability calculations with those determined by laboratory testing. Properties of the gravel shell material were estimated by comparison to test data for similar material.

The dam stability analysis calculations included an allowance for earthquake loading caused by an acceleration of one-tenth that of gravity.

TABLE 7

MATERIAL PROPERTIES USED FOR DAM STABILITY ANALYSES

Material	Property	Unit	Used for Stability Analysis	Results of Lab Tests
Foundation	Density -- dry	Pcf	104	94, 99, 99, 105, 107, 108, 111, 112
	Density -- saturated	Pcf	129	---
	Phi angle -- total	---	28^{o}	28^{o}
	Cohesion -- total	Tsf	0	0
	Phi angle -- effective	---	33^{o}	33^{o}
	Cohesion -- effective	Tsf	0	0
Impervious core	Density -- dry	Pcf	106	106, 114
	Density -- moist	Pcf	127	---
	Density -- saturated	Pcf	130	---
	Phi angle -- total	---	20^{o}	20^{o}
	Cohesion -- total	Tsf	0	0
	Phi angle -- effective	---	27^{o}	27^{o}
	Cohesion -- effective	Tsf	0	0
Gravel shell and transition	Density -- dry	Pcf	120	---
	Density -- moist	Pcf	125	---
	Density -- saturated	Pcf	139	---
	Phi angle	---	35^{o}	---
	Cohesion	Tsf	0	---

The design of both dam slopes was controlled by the earthquake loading condition combined with steady seepage. Minimum safety factors used for the earthquake loading condition were 1.20 on the basis of effective stresses and 1.10 on the basis of total stresses. The total stress criteria were found to control the design.

The relatively large berms on both dam slopes were found necessary to provide safety against deep-seated failure surfaces through the foundation material. The one triaxial compression test run on the foundation material was run on samples from shallow depth due to sampling difficulties. The density of those samples varied from 94 to 99 pounds per cubic foot, while samples from greater depths showed densities from 105 to 112 pounds per cubic foot. Additional testing during final design studies may permit selection of more favorable design parameters for the foundation material with a substantial reduction in the amount of material required for the dam.

No source of rock for riprap is near the Ewing damsite. The dredger tailings proposed for use in the dam shell are mostly smaller than 6 inches, but occasionally rocks up to 12 inches are encountered. It was assumed that the larger rocks would be moved to the upstream dam slope during construction. This would provide a measure of protection against wave wash, which should not be severe in the sheltered location of Ewing Reservoir. Occasional maintenance of the upstream slope might be required; it was felt that this would be less expensive than bringing in riprap from a distant source.

Ewing Gulch is dry during the summer months and Ewing Dam could be constructed in the July-September period to avoid diversion problems. Stripping, clearing, and other operations could be essentially completed while any small amount of streamflow was left in the natural channel. Therefore, only a nominal sum was included in the cost estimate for diversion and care of the stream. The Ewing Project could be completed during one construction season without difficulty. The total quantity of embankment to be placed is about 142,000 cubic yards; this could be accomplished in two to three months with moderate production rates.

Ewing Reservoir

At the normal water surface elevation of 2,428 feet, Ewing Reservoir would impound about 820 acre-feet and have a surface area of about 42 acres. Reservoir area and capacity curves are presented on Plate 2.

The proposed reservoir area is covered with scattered oaks, pines, and brush. The land is currently not in use except for a minor amount of cattle grazing. A total of about 210 acres would be required for the Ewing Project to provide access to the reservoir for fishing and to avoid severance damages and access problems. In addition, one easement would be required for an access road and another for a pipeline to the existing district regulation reservoir.

The proposed land acquisition for the Ewing Project would involve four separate parcels; two would be purchased in entirety and minor portions of the other two would be purchased. Land acquisition costs were estimated by the Department's Division of Right-of-Way Acquisition. Valley floor lands in Ewing Gulch were valued at $200 per acre and the remaining lands at $150 per acre. The total estimated cost of 210 acres required for the Ewing Project, including acquisition costs, was $42,300.

A paved access road would be constructed from State Highway 3 to the toe of Ewing Dam and a spur road would connect to the dam crest on the left abutment. Parking space would be provided near the dam toe; access to the dam crest would be restricted to authorized personnel.

Spillway

An uncontrolled overflow, chute-type spillway would be located on the right abutment of Ewing Dam. The spillway would be founded entirely on Weaverville formation clayey sediments. A spillway crest width of 10 feet was selected as the minimum practical for construction. Flood routings were made for the probable maximum flood and an assumed standard project flood with inflows equal to six-tenths of those of the probable maximum flood. The results of these spillway routings are shown below:

Flood	Crest Length	Crest Elevation	Maximum Water Surface Elevation	Maximum Spillway Discharge
PMF	10 feet	2,428	2431.5	260 cfs
SPF	10 feet	2,428	2430.4	140 cfs

The spillway control structure would be a conventional ogee weir section 10 feet in length. The approach channel would be unlined, with a bottom elevation of 2,425 feet. The spillway weir would extend at least 4 feet

below the bottom of the approach channel to ensure good cutoff, and pipe underdrains would be provided near the downstream toe of the weir.

The spillway chute would be a rectangular flume section, without longitudinal joints. It would have a width of 10 feet and a wall height of 2.5 feet. The chute would be about 290 feet long, with a uniform slope of 18 percent. Collars would extend 3 feet into the foundation at 20-foot intervals to anchor the chute. A gravel underdrain system would be provided. Flow routings through the chute for the probable maximum flood discharge of 260 cfs show that uniform flow at a depth of 0.75 foot would prevail throughout most of the chute. The maximum velocity of flow would be about 35 feet per second.

A spillway stilling basin would be required because of the erosive nature of the channel deposits. Due to the small discharge involved, and the lack of tailwater, a hanging baffle impact-type stilling basin was selected. The basin was designed for the standard project flood spillway discharge of 140 cfs, which would enter the stilling basin with a velocity of about 27 feet per second. An exit channel about 220 feet long would then convey the water back to the Ewing Gulch channel about 300 feet below the dam toe.

Total spillway excavation, based on 1.5:1 cut slopes along the chute section, would be about 5,400 cubic yards. Since most of this excavation would be quite shallow and within the root zone, it was assumed that all spillway excavation would be wasted.

Outlet Works

The outlet works for Ewing Reservoir would consist of a simple intake structure near elevation 2,400 on the left dam abutment and a concrete encased 24-inch steel pipe beneath the embankment. The pipe would deliver water under full reservoir head to a pumping plant located near the dam toe. The 24-inch pipe was selected as the minimum size which would permit inspection and maintenance although a smaller pipe would be adequate for the required reservoir releases. No releases would normally be made down Ewing Gulch, but a 12-inch bypass would be provided at the pump house for emergency use in lowering the reservoir. With the reservoir full, the bypass could discharge about 20 cfs and the reservoir could be lowered at a rate of about 1 foot per day. Complete emptying of the reservoir would require pumping the last 100 acre-feet, which lie below the level of the intake.

The intake would be an inclined structure founded on the left abutment at the edge of the embankment. An 18- by 18-inch slide gate would be provided for emergency closure; the gate would be hand operated from the dam crest. An inclined trashrack would be installed over the intake. The trashrack would be mounted on flanged wheels and rails would be provided up the face of the dam so that it could be raised for cleaning. The gate stem and trashrack rails would be combined and supported on concrete footings on the dam face. A hand-operated winch would be provided to raise the trashrack. Because of small natural streamflow, trash is not expected to be much of a problem, and the trashrack bars could be spaced close enough to exclude most fish.

The outlet conduit would consist of a 24-inch cement-lined steel pipe in a trench, backfilled with concrete. The trench would be excavated into the foundation clays after all other foundation excavation was completed. The maximum height of embankment over the outlet conduit would be about 40 feet. An analysis of foundation settlement, using the result of the consolidation test on an undisturbed sample of the foundation clay, indicated that the maximum settlement (at the stream channel for the full 60-foot dam height) would be about 0.8 foot. The settlement at the outlet conduit, located higher on the abutment, would be somewhat less. It was concluded that it would be safe to install the outlet conduit as described, as long as provision was made to accommodate some settlement. Conventional cutoff collars would be installed on the outlet conduit beneath the core section of the dam.

Pumping Facilities

Water from Ewing Reservoir would be delivered to a water treatment plant located adjacent to the existing 3 acre-foot regulation reservoir some 1,800 feet southeast of Ewing Dam. That regulation reservoir is located at an approximate elevation of 2,565 and water would have to be pumped somewhat higher to the treatment plant. The pumping plant would be located near the dam toe on the left abutment and would receive water from the outlet works under full reservoir head. The initial pump installation would be sized for the projected demand in 20 years. That demand would require a maximum pumping rate of 2 cfs based on 20-hour-per-day operation on the peak day of the year. Total dynamic pumping head would range from 160 to 195 feet. Two 4-inch, 30-horsepower centrifugal pumps would be installed initially. A corrugated

metal building of about 400 square-feet would be provided to house the pumps and associated equipment. The pumping plant discharge line would consist of a 12-inch diameter buried cast-iron pipe about 1,800 feet in length.

Water Treatment Facilities

Studies of the potential quality of Ewing Reservoir water indicated that full treatment of the water prior to delivery to the existing district regulation reservoir would be necessary. The treatment, which would include coagulation, sedimentation, filtration, and disinfection, would be required primarily for control of color, turbidity, taste, and odor. The taste and odor problems are expected to be due to the growth of algae in the reservoir during the relatively long periods of storage. The State Department of Public Health concurs with the recommendation for complete treatment.

Preliminary studies of the treatment plant requirements were based on the assumption that the plant would be sized for a maximum day demand of twice the average day demand, which results in a required plant capacity ranging from 0.40 million gallons per day (mgd) in 1967 to 1.60 mgd in 2017. Studies of treatment plant capital and operating costs resulted in the following conclusions:

1. Sizing of the treatment facilities for flows in excess of the maximum daily demand would not be economical. Although this would permit operation for a shorter period each day, the savings in operating costs with a larger installation would not offset the additional capital investment.

2. The lowest total cost would result if the plant were constructed initially with a capacity equal to the maximum daily demand of the year 2017. However, due to the uncertainties involved in projecting demands, and the fact that staged construction would result in only a small increase in total cost, it was concluded that the treatment facilities should be constructed in two stages as follows:

Stage 1: 0.8 mgd (1967)
Stage 2: Enlarge to 1.6 mgd (1977)

No detailed design studies were made of the water treatment facilities required for the Ewing Project. However, it was concluded that a plant

combining solids-contact pretreatment and filtration into a single unit showed promise as being most economical for the required service. Cost data were developed from records of cost of existing treatment plants of similar capacity and from contact with a manufacturer of water treatment equipment. The capital costs of the first and second stages of construction were estimated as $175,000 and $100,000.

Recreation Facilities

Recreation at Ewing Reservoir would be limited to nonwater-contact use and would be primarily fishing use. Access to the reservoir would be permitted only by trail from the base of the dam and relatively few recreation facilities would be required. One pair of pump-out type chemical toilets would be provided near the dam, and one pair of pit toilets would be provided on each side of the reservoir. Six portable wooden picnic tables would be placed along the reservoir and garbage cans would be provided throughout the area. The estimated capital cost of these facilities is $7,000, of which about $6,000 would be for sanitary facilities.

Cost Estimate

An itemized cost estimate of the Ewing Project is presented in Table 8. Estimated capital cost of the project, with the exception of the water treatment plant costs described above, is $586,000. Of that total, about 50 percent is represented by the dam structure and 10 percent by the cost of land acquisition. The estimated unit costs of the main items of the dam structure were examined in considerable detail, as described in the following paragraphs, and the cost of land acquisition was estimated by the Division of Right-of-Way Acquisition. Unit costs for all other items of the cost estimate were selected after examination of bid prices on similar projects.

Unit costs for embankment materials were developed by estimating the necessary construction plant and labor forces and calculating unit costs from hourly equipment and labor cost schedules. Possible haul routes were laid out and haul road construction costs were included in the costs of the impervious material and the dredger tailings.

Material for the dam core would be obtained from the reservoir, about one-fourth mile north of the damsite, as shown on Plate 2. Haul would be on a gentle downgrade along the relatively broad floor of Ewing Gulch.

TABLE 8

ESTIMATED COST OF EWING PROJECT
(Price level: 1964)

Dam crest elevation: 2,435 feet
Height of dam above streambed: 60 feet
Spillway crest elevation: 2,428 feet
Reservoir capacity at spillway crest: 820 acre-feet

Item	Unit	Quantity	Unit Price	Total Cost	
Dam					
Diversion and care of stream	lump sum			$ 1,000	
Excavation (bank measure)					
Stripping and cutoff trench	cu yd	30,000	$ 0.50	15,000	
Impervious - Borrow Area No. 1					
Strip and waste	cu yd	8,000	0.30	2,000	
Zone 1 - Impervious	cu yd	42,000	0.55	23,000	
Tailings - Borrow Area No. 2					
Strip and waste	cu yd	19,000	0.30	6,000	
Zone 2 - Transition	cu yd	14,000	1.80	25,000	
Zone 3 - Pervious	cu yd	96,000	1.05	101,000	
Embankment (fill measure)					
Zone 1	cu yd	38,000	0.20	8,000	
Zone 2	cu yd	13,000	0.30	4,000	
Zone 3	cu yd	91,000	0.20	18,000	
Miscellaneous costs	lump sum			12,000	
Subtotal					$215,000
Spillway					
Excavation, common, waste	cu yd	5,400	1.50	8,000	
Concrete					
Weir	cu yd	15	50.00	1,000	
Chute	cu yd	200	50.00	10,000	
Walls	cu yd	80	100.00	8,000	
Stilling basin	cu yd	25	125.00	3,000	
Cement	bbl	410	5.50	2,000	
Reinforcing steel	lb	40,000	0.20	8,000	
Drains	lin ft	300	6.00	2,000	
Structural backfill	cu yd	300	4.50	1,000	
Riprap	cu yd	100	5.00	1,000	
Bridge	sq ft	200	15.00	3,000	
Subtotal					$ 47,000
Outlet Works					
Excavation, common	cu yd	400	5.00	2,000	
Concrete					
Conduit	cu yd	150	40.00	6,000	
Other	cu yd	20	100.00	2,000	
Cement	bbl	100	5.50	1,000	
Reinforcing steel	lb	17,000	0.20	3,000	
Steel pipe, 24-inch	lb	15,000	0.60	9,000	
Trashrack and guides	lump sum			2,000	
Slide gate, 18" x 18"	lump sum			1,000	
Subtotal					$ 26,000

TABLE 8 (continued)

ESTIMATED COST OF EWING PROJECT

Item	Unit	Quantity	Unit Price	Total Cost	
Pumping Facilities					
Pump building	sq ft	400	$ 15.00	$ 6,000	
Pump and motor, 30 H.P.	each	2	2500.00	5,000	
Valves and piping	lump sum			2,000	
Electrical equipment	lump sum			2,000	
Discharge line, 12" CIP	lin ft	1,800	12.00	22,000	
Transmission line	lump sum			3,000	
Subtotal					$ 40,000
Reservoir					
Land acquisition					
Valley floor	acre	40	200.00	8,000	
Other	acre	170	150.00	26,000	
Acquisition costs	parcel	4	2000.00	8,000	
Easements	lump sum			1,000	
Clearing	acre	55	100.00	6,000	
Access roads (0.6 mile)	lump sum			14,000	
Subtotal					$ 63,000
Diversion Facilities					
Excavation, canal	cu yd	7,000	1.50	11,000	
Headworks and fish screen	lump sum			5,000	
Flume	lin ft	100	30.00	3,000	
Cross drainage structures	each	9	200.00	2,000	
Siphon, 24-inch	lin ft	120	20.00	2,000	
Miscellaneous structures	lump sum			2,000	
Bridges (farm use)	each	8	300.00	2,000	
Fencing	lin ft	24,000	0.50	12,000	
Subtotal					$ 39,000
Subtotal, all items					430,000
Contingencies, 15%					64,000
Subtotal					494,000
Engineering and administration, 15%					74,000
Subtotal					568,000
Interest during construction					11,000
Capital cost of dam, reservoir, diversion and pumping facilities					$579,000
Capital cost of recreation facilities					7,000
Capital cost of first stage water treatment plant (0.8 mgd)					175,000
TOTAL INITIAL PROJECT CAPITAL COST					$761,000
Capital cost of enlargement of treatment plant (1977)					100,000
GRAND TOTAL - PROJECT CAPITAL COST					$861,000

The unit cost estimate was based on the use of scrapers. Two scrapers would be required, but one would be needed only part of the time and could be used for stripping or other work. Downhill loading could be used throughout the job. One ripper-equipped pusher tractor would be required; some ripping might be required for the more compact zones of the borrow area. Average depth of borrow was assumed as 12 feet, with the top 2 feet wasted; the total area of borrow would be about 3 acres. No field moisture tests were run on the potential impervious borrow material, but eight tests on similar material from the dam foundation showed field moisture contents ranging from 18 to 28 percent. Optimum moisture contents from compaction tests of the proposed borrow material were 16 and 21 percent. Due to its location on higher ground, the borrow area should yield somewhat drier material than that from the dam foundation. Water to be added to the impervious fill material would have to be hauled from Hayfork Creek, but the amount should not be large.

Material meeting the grading requirements for the transition, Zone 2, was assumed to be obtained by removing the plus three-fourth-inch fraction from the lower portions of the dredger tailing piles after the upper portion was removed for use in the dam shell. A portable single-deck screening plant could be operated in the borrow area. It was estimated that 50 percent of the material entering the screening plant would be rejected as oversize; the remainder would be stockpiled for use as required. The required 14,000 cubic yards of specification material could be stockpiled in about four weeks, and the screening operation could be discontinued.

Material for the pervious dam shell, Zone 3, would be obtained from dredger tailing deposits along the south side of Hayfork Creek, as shown on Plate 1. The tailings from that area should be suitable for placement directly on the dam without processing. Haul distance would be about 6,200 feet, with an upgrade of about 3 percent. The haul route would cross Hayfork Creek on a temporary fill and culvert structure. About 1,800 feet of the haul route would follow an existing paved county road. The unit cost estimate was based on the use of highway rear-dump trucks and tractor loaders. The average depth of borrow was assumed as 5 feet, after 1 foot was stripped from the surface to remove trees and grass. A total borrow area of about 12 acres would be required.

CHAPTER V. ECONOMIC JUSTIFICATION

A water development project is considered to be economically justified if: (1) estimated total economic benefits exceed estimated total economic costs; (2) each separable purpose provides benefits at least equal to its costs; and (3) there is no more economical means of accomplishing the same purpose. This chapter describes the studies relating to the economic justification of the Ewing Project.

Methods of Economic Analysis

The Ewing Project was analyzed by evaluating the costs and benefits associated with domestic water supply within the study area, first with the present water system only, and second with the Ewing Project constructed. The differences in total benefits and total costs, with and without the project, were attributed to the Ewing Project. For the purpose of these calculations, the area of study was considered to coincide with the present and future area of the Trinity County Waterworks District No. 1. All economic studies were based on a 50-year period of analysis and an interest rate of 4 percent. The period of analysis was selected to conform to the earliest likely construction date and includes the years from 1967 through 2017.

Benefits

Project benefits represent advantages to project beneficiaries of receiving project water or other project products and services. Benefits from the Ewing Project would be derived from urban water supply to the Hayfork area and from fisheries enhancement and recreation use of Ewing Reservoir.

Evaluation of Water Supply Benefits

Two methods are available for evaluation of the benefits from the supply of urban water. The primary method is that of "alternative cost", in which the cost of the most economical alternative means of supply is taken as the measure of benefits. The alternative cost method requires that the cost of the alternative would not result in appreciable curtailment of use. In the case of the Ewing Project, no reasonable alternative

means of supply is known to exist; the least costly alternative found during the 1963 reconnaissance study was the Layman Project on Hayfork Creek, which was estimated to cost more than $3 million. Accordingly, it was concluded that the alternative cost method was not applicable to the determination of urban water supply benefits from the Ewing Project.

The second method of evaluating urban water supply benefits involves the concept of "vendibility" in which the benefits are taken to be equal to the maximum average amount that a customer would be willing to pay for project water, rather than receive no project water at all. The vendibility of urban water in the Hayfork area was based on the current cost of water in the area, as described in the following paragraphs.

The average annual revenue to the district for the last five years (1959-60 through 1963-64) has ranged from $66 to $72 per service with an average of $69. During the same period, average taxes levied for support of the water district ranged from $20 to $37 per service per year with an average of $25. Therefore, the recent direct cost of water service to the average customer of the Trinity County Waterworks District No. 1 has been about $94 per year.

Most of the present district customers are connected to the original distribution system which was financed with the 1952 bond issue; their average annual expenditure of $94 thus represents the total cost to them for water service at their property lines. However, the district does not construct new water lines but accepts ownership and responsibility for operation of lines installed at the expense of landowners or subdividers. Therefore, those customers of the district who are not connected to the original distribution system are paying indirectly for the costs of distribution lines as a part of the prices of lots, etc. The estimated cost of distribution lines is about $550 per lot, which represents an annual cost of about $26, based on a 50-year repayment period at an interest rate of 4 percent.

The above annual costs of $94 and $26 were combined to arrive at an estimate of the minimum value of the annual vendibility under present conditions. This value is expressed as the average total amount that an individual customer would be willing to pay for water service at his property line. The true vendibility, defined as the maximum average amount that a customer is willing to pay, would be somewhat higher than the calculated minimum value of $120 per service per year. However, the cost of water in the Hayfork area

is already rather high in relation to per capita income, and the true vendibility is felt to be very close to the calculated value. The minimum value of vendibility under present conditions of $120 per service per year was used in evaluating benefits under nonproject conditions.

Under project conditions, per capita water use was estimated to increase from its present level of about 120 gallons per capita per day (gpcpd) to 150 gpcpd immediately after project construction and to 200 gpcpd by 1997. The customer's willingness to pay for water service should increase in the future with an increase in the amount of water used. A 1960 survey of municipal water rates in California showed that the average incremental cost of water over the minimum quantities required was about 16 cents per 100 cubic feet. The increase in a customer's willingness to pay due to an increase in use from 120 to 200 gpcpd was assumed to be represented by the average incremental cost of 16 cents per 100 cubic feet. On that basis, the weighted average increase in willingness to pay, over the 50-year period of analysis, was found to be $17 per year. This $17 was added to the $120 per year calculated as the vendibility under nonproject conditions to establish a minimum annual vendibility of $137 per service for urban water supply under project conditions. This minimum vendibility of $137 per service per year was used for evaluation of water supply benefits under project conditions.

Evaluation of Fisheries Enhancement and Recreation Benefits

As discussed in Chapter III, it was concluded that recreation should be limited to nonwater-contact use of Ewing Reservoir. The main recreation activities at the reservoir in the early years of operation would consist of warm-water fishing. Benefits from this type of recreation use were developed from predictions of the probable origin of the anglers and studies which measured the dollar value to the individual fisherman. Applying the Department's "consumer surplus" method of estimating recreation benefits resulted in an angler-day benefit of $2.

Total Benefits Without Project

The benefits which would accrue in the absence of the Ewing Project would be derived entirely from the supply of urban water by the existing water system of the Trinity County Waterworks District No. 1. This system, completed in 1953, was designed for 250 connections but has been serving a greater

number since 1958. However, the supply source for the existing system is not adequate for the present demands and water shortages have occurred in recent years. In order to evaluate the benefits from urban water supply without the Ewing Project, it was assumed that the present system could serve the design load of 250 connections with safety at present levels of water use. The calculations of benefits under nonproject conditions were based on operation of the existing system to serve 250 users only, for the entire 50-year period of analysis. Using the value of $120 per service per year for the vendibility of urban water as described above, the total annual benefit would be $30,000. The present worth of benefits under nonproject conditions was calculated as $644,000.

This method of approach, in effect, credits the Ewing Project with: (1) permitting an increase in the number of users above the design capacity of the existing system, and (2) permitting an increase in per capita water consumption above the present level of about 120 gpcpd.

Total Benefits With Project

Benefits with the Ewing Project constructed would be derived from both urban water supply and recreation. The present worth of water supply benefits, based on the previously described minimum average vendibility of $137 per service per year, and the projected number of services from Table 2, is shown in the following tabulation:

Year	Number of Services	Total Benefits During Decade	Present Worth
1967	377		
		$ 688,000	$ 566,000
1977	628		
		986,000	547,000
1987	811		
		1,215,000	456,000
1997	963		
		1,319,000	334,000
2007	963		
		1,319,000	226,000
2017	963		
		Present worth of water supply benefits	$2,129,000

Similarly, fisheries enhancement and recreation benefits, based on the benefit of $2 per day and the projected number of users from Chapter III, are shown in the following tabulation:

Year	Fishing and Recreation Use User-days	Total Benefits During Decade	Present Worth
1967	2,200		
		$ 45,000	$ 37,000
1977	2,300		
		48,000	27,000
1987	2,500		
		57,000	21,000
1997	3,200		
		75,000	19,000
2007	4,300		
		96,000	16,000
2017	5,300		
	Present worth of fisheries enhancement and recreation benefits		$ 120,000

Benefits Attributable to Project

The benefits attributable to the Ewing Project were evaluated as the difference in total benefits with and without the project as follows:

	Present Worth
Benefits with Ewing Project	
Water supply	$ 2,129,000
Fisheries enhancement and recreation	120,000
Subtotal	2,249,000
Benefits without Ewing Project	644,000
Benefits attributable to project	$ 1,605,000

Costs

The cost attributable to the Ewing Project was determined in the same manner as the benefits, by evaluating costs both with and without the Ewing Project. The costs included all costs associated with urban water supply within the study area which would be borne by the residents of the district.

Costs Without Project

The costs of urban water supply in the district area under nonproject conditions were estimated for the existing water system operating at its design capacity of 250 connections for the entire 50-year period of analysis. The costs borne by the water users under this condition were broken down into: (1) repayment of existing district debt; (2) replacement of existing

distribution system; and (3) operation and maintenance costs. The total present worth of these costs was found to be $561,000 as described in the following paragraphs.

Repayment of Existing Debt. The existing water system of the Trinity County Waterworks District No. 1 was financed with a total of $230,000 in general obligation bonds. These bonds are being redeemed at the rate of $10,000 per year; the current (July 1965) outstanding balance is $110,000, and the last bonds will be redeemed in October 1975. All the remaining outstanding bonds bear an interest rate of 4 percent. The present worth (1967 basis) of the bond redemption payments from 1967 through 1975 is $94,000.

Replacement of Existing Distribution System. The main portion of the existing distribution system was completed in 1953, and various additions and extensions have been made since then. As noted in Chapter II, the condition of the existing distribution system is not particularly good. Ordinarily a distribution system could be expected to have a useful life of 50 years or more, but it is likely that earlier replacement would be required for much of the existing district system. Accordingly, allowance was made for gradual replacement of the entire original portion of the system by the time it reached the age of 50 years. It was assumed that the additions to the original system would be replaced after about 50 years of life, in the years from 2005-2015. Based on present cost levels, the total future expenditures for replacement of the existing distribution system would be about $370,000, and their present worth was found as $140,000.

Operation and Maintenance. The basic cost of operation and maintenance of the existing system serving a constant 250 users was estimated as $12,500 per year based on the average annual cost per connection during the 11 years the district has been in operation. To this was added the cost of pumping power, estimated as $1,600 per year, and an extra allowance equivalent to an annual expense of $1,100 for extra operation and maintenance costs associated with the deteriorating existing distribution system during the period in which it would be replaced. The resulting total equivalent annual cost was thus estimated as $15,200, and the present worth of future operation and maintenance costs under nonproject conditions was found as $327,000.

Costs With Project

The total cost of urban water supply within the study area under Ewing Project conditions was estimated for the 50-year period of analysis using the projected demand build-up for the first 30 years and the estimated project capacity of about 960 users for the last 20 years. Costs were broken down into: (1) repayment of existing district debt; (2) replacement of existing distribution system; (3) project capital costs; (4) operation, maintenance, and replacement; and (5) distribution system extensions. The total present worth of these costs was found to be $2,075,000 as described in the following paragraphs.

Repayment of Existing Debt. The present worth (1967 basis) of the annual payments through 1975 for redemption of the outstanding district bonded indebtedness was found to be $94,000 as described in the "Costs Without Project" section.

Replacement of Existing Distribution System. Future expenditures for replacement of the existing distribution system would be the same as calculated for nonproject conditions. The present worth of these expenditures was found as $140,000.

Project Capital Costs. Capital expenditures for the Ewing Project were estimated as $761,000 initially and $100,000 after 10 years for expansion of the water treatment facilities. The present worth of these estimated capital expenditures is $829,000.

Operation, Maintenance, and Replacement. Rather detailed estimates were made of the costs of operating the entire district water system during the period of analysis. An account of these estimates is presented in Table 9. The costs for the period after 1997 reflect the projected increase in per capita use during that period although that increase in use could not be supplied from the safe yield of the project and was not included in the benefit analysis. The departure of the projected operation, maintenance, and replacement costs from a smooth curve is due to the influence of the staged construction of the water treatment plant. The present worth (1967) of all estimated operation, maintenance, and replacement costs was found as $912,000.

TABLE 9

ESTIMATED ANNUAL OPERATION, MAINTENANCE, AND REPLACEMENT COSTS
FOR TRINITY COUNTY WATERWORKS DISTRICT NO. 1 WITH EWING PROJECT

Item	Year					
	1967	1977	1987	1997	2007	2017
Labor	$13,800	$16,800	$16,800	$19,200	$19,200	$19,700
Administrative costs	2,500	3,500	4,200	5,000	5,100	5,200
General overhead	2,100	2,100	2,200	2,200	2,300	2,300
Services	200	400	500	600	600	600
Equipment	3,700	3,800	4,100	4,200	4,400	4,500
Materials and supplies	5,300	7,800	10,000	12,200	12,400	13,000
Power	1,800	2,800	3,700	4,600	4,900	5,000
Replacement	1,500	1,500	1,500	1,500	1,500	1,500
O and M of recreation facilities	400	500	500	600	900	1,100
Total O M and R	$31,300	$39,200	$43,500	$50,100	$51,300	$52,900
O M and R for Treatment Plant Only						
Labor	$ 7,100	$ 8,900	$ 8,700	$10,400	$10,900	$11,300
Chemicals	3,000	5,700	7,900	10,300	11,000	11,600
Power	100	200	300	400	500	500
Replacement	500	500	500	500	500	500
Total	$10,700	$15,300	$17,400	$21,600	$22,900	$23,900
Treatment cost per acre-foot	$46	$35	$28	$27	$27	$27

Labor and administrative costs were derived by estimating the manpower requirements for each decade. The costs for general overhead and services were based on data from recent annual reports by the district. Estimates were made of the required equipment, materials, and supplies; the major part of these costs would be for water treatment chemicals. Power costs were calculated from established rate schedules.

Replacement costs allow for establishment of a sinking fund to replace those parts of the project such as gates, valves, pumps, and parts of the water treatment plant which have a normal economic life shorter than the 50-year period of study.

Operation and maintenance of the recreation facilities would involve maintenance of the chemical toilets, trash removal and cleanup, and general supervision of use at the reservoir. Due to the relatively light use predicted for the project, it was assumed that general supervision could be exercised as a part of the normal duties of the district maintenance personnel. A unit cost of 20 cents per visitor-day was used as the additional cost to the district due to the use of Ewing Reservoir for fishing and recreation.

Distribution System Extensions. Under the present district policies, no expenses would be incurred by the district for extensions of the distribution system. However, these extensions would represent a cost of obtaining water service to those future customers served by them. Accordingly, the costs of extensions to the distribution system were treated as associated costs borne by the individual users and considered in the economic analysis of the project. The total cost of future extensions was estimated as $160,000 and the present worth of these expenditures was estimated as $100,000. These expenditures include both the cost of new mains for those future customers outside the present service area and the hookup costs which would be paid by new customers on the existing system. It was estimated that approximately 40 percent of future new customers would be served by extensions of the existing system and that the remainder would be served from the existing system, which currently serves relatively few users per mile of line.

Costs Attributable to Project

The cost attributable to the Ewing Project was evaluated as the difference in the present worth of costs with and without the project:

	Present Worth
Cost with Ewing Project	$ 2,075,000
Cost without Ewing Project	561,000
Cost attributable to project	$ 1,514,000

Economic Justification

The benefits attributable to the Ewing Project, $1,605,000, exceed the costs attributable to the project, $1,514,000. The benefit-cost ratio, calculated after deducting the $100,000 in associated costs from both the project benefits and project costs, is:

$$\text{Benefit-cost ratio} = \frac{1,605,000 - 100,000}{1,514,000 - 100,000} = 1.06$$

Each project purpose provides benefits in excess of its separable cost, and there is no known means of accomplishing the project purposes more economically. The Ewing Project is therefore found to be economically justified.

CHAPTER VI. FINANCIAL FEASIBILITY

A project is considered to be financially feasible if: (1) sufficient capital is authorized and available to finance construction to completion; (2) beneficiaries are willing and able to pay the costs of project services and products; and (3) estimated revenue during the repayment period is sufficient to recover reimbursable project costs.

Cost Allocation

The Ewing Project would serve two primary purposes, urban water supply and fisheries enhancement and recreation. Cost allocation is the process by which the financial costs of the project are distributed among the project purposes and, in turn, to the two groups of beneficiaries. The State considers fisheries enhancement and recreation as nonreimbursable costs; consequently, the Trinity County Waterworks District No. 1 would be eligible to apply for a grant from the State for that portion of the cost of the Ewing Project which could be properly allocated to fisheries enhancement and recreation.

An allocation of costs among project purposes was made by the separable costs-remaining benefits method. This method provides for distribution of costs by identifying the separable cost of each purpose, and then allocating the remaining costs in proportion to the remaining benefits associated with each purpose.

Estimates of project benefits and costs were presented in Chapter V. The other data needed for the cost allocation are the alternative and separable costs for the project purposes. The alternative cost of a project purpose is the cost of the least costly single-purpose alternative means of providing the same benefits. The alternative cost of water supply was not evaluated since it was shown in earlier studies to be substantially greater than the cost of the Ewing Project and thus would not affect the allocation of costs. The alternative cost of fisheries enhancement and recreation was based on a smaller reservoir at the Ewing site which would support the same fishing use as the proposed reservoir. This alternative reservoir would have a gross storage capacity of 500 acre-feet. Its capital cost was estimated as $400,000, and the present worth of future operation and maintenance costs was estimated as $40,000.

The separable cost of a project purpose is that cost which could be eliminated if that purpose were excluded from the project. Thus, the separable cost of water supply was found as the difference between the cost of the Ewing Project and the cost of the alternative fisheries enhancement and recreation project. The separable cost of fisheries enhancement and recreation is the cost of the recreation facilities which could be omitted. The allocation of costs among the project purposes is presented in Table 10.

TABLE 10

ALLOCATION OF EWING PROJECT COSTS

Item	Water Supply	Fisheries Enhancement and Recreation	Total
Benefits	$ 1,385,000	$ 120,000	$ 1,505,000
Alternative costs	(greater)	440,000	---
Justifiable costs	1,385,000	120,000	---
Separable costs	974,000	19,000	993,000
a. Capital	429,000	7,000	436,000
b. O. M. and R.	545,000	12,000	557,000
Remaining justifiable costs	411,000	101,000	512,000
Percent distribution	80.3	19.7	100
Total project cost			1,414,000
Total separable cost			993,000
Total remaining joint costs			421,000
Allocated remaining joint costs 1/	338,000	83,000	421,000
a. Capital	316,000	77,000	393,000
b. O. M. and R.	22,000	6,000	28,000
Total allocation 2/	1,312,000	102,000	1,414,000
a. Capital	745,000	84,000	829,000
b. O. M. and R.	567,000	18,000	585,000
Capital cost allocated to fisheries enhancement and recreation			84,000
Cost of onshore recreation facilities			7,000
Potential fisheries enhancement and recreation grant			77,000
Potential grant for sanitary facilities			6,000
Total potential grants			83,000

1/ These costs are allocated in accordance with the percentage distribution of remaining justifiable costs.

2/ Summation of separable costs and allocated remaining joint costs.

Project Financing

Three general sources of capital might be used for construction of the Ewing Project. These are: (1) private financing through sale of bonds; (2) federal financing through grants and loans; and (3) state financing through grants and loans under the Davis-Grunsky Act. The possibilities of obtaining private or federal financing for the Ewing Project were not explored during this study. However, it is believed that the chances of obtaining private funds at reasonable cost are rather remote due to the district's outstanding debt and relatively low assessed valuation in relation to the amount of funds required. Furthermore, repayment analyses show that the district would be financially unable to begin repayment of Ewing Project costs until the present debt is retired in 1975. Likewise, the present possibilities for obtaining financial assistance from the federal government are very limited. Therefore, the remainder of this chapter primarily concerns financing with state funds under the terms of the Davis-Grunsky Act. Nevertheless, it will be necessary for the district to give full consideration to the other possible sources of funds before it can receive a loan under the Davis-Grunsky Act to proceed with construction of the Ewing Project.

The Davis-Grunsky Act provides for state financial assistance to public agencies for the construction of water projects to meet local requirements by making grants or loans, or both. Eligible projects include those primarily for domestic, municipal, agricultural, recreation, or fish and wildlife purposes, and in conformance with the California Water Plan. An agency applying for a construction loan must demonstrate that it cannot obtain funds on reasonable terms from other sources. The Ewing Project appears to qualify as an eligible project under the Davis-Grunsky Act. The Trinity County Waterworks District No. 1 would qualify as an eligible agency and should be eligible to receive a loan provided that it could demonstrate inability to finance from other sources at reasonable interest rates at the time of application. The maximum repayment period for construction loans under the Davis-Grunsky Act is 50 years. A development period of up to 10 years is allowed during which payments of principal and interest may be deferred; however, interest is charged on any payments which are deferred.

The interest rate on loans is determined on the basis of the average net interest cost to the State on recent sales of general obligation bonds. The rate is reset on January 1 of each year and is currently 3.3 percent (1965).

Once the rate is established for any given loan, it will remain constant during the life of the loan contract.

Under the terms of the Davis-Grunsky Act, the district would be eligible to apply for a grant for that portion of the construction cost properly allocated to fisheries enhancement and recreation. No provision is included in the act for grants for recreation facilities such as picnic tables and boat ramps, but grants may be made for initial water supply and sanitary facilities needed in connection with public recreational use. Based on the cost allocation presented in Table 10, the district would be eligible to apply for a fisheries enhancement and recreation grant of $77,000 and a grant for initial sanitary facilities of $6,000.

Repayment Analysis

Two sources of revenue are available for repayment of a loan used for construction of the Ewing Project. These sources, which are the same as used for support of the existing water service, are water tolls and ad valorem taxes. The total financial burden may be divided between the two sources in a variety of ways to produce various effects, such as encouraging residents to abandon private water systems, or discouraging high use of water, etc. The apportionment of the total cost between water tolls and taxes is largely a local decision to be made by the district directors. For a detailed repayment analysis, it was assumed that the present monthly water rate structure would be modified as shown below:

	Existing Rate	Assumed Rate
First 1,000 C.F. (minimum)	$5.50	$5.50
Next 1,000 C.F. (per 100 C.F.)	0.10	0.20
Over 2,000 C.F. (per 100 C.F.)	0.10	0.15

This modification in rate schedule would result in an average annual increase in water charges of about $7 per connection at present rates of use. The rates for water use above the minimum amount would be similar to the statewide average; the increase in rates for use above the minimum amount would be logical since the present rate of 10 cents per 100 cubic feet would be less than the incremental cost of pumping and water treatment with the Ewing Project in operation.

A year-by-year analysis of the repayment of reimbursable costs of the Ewing Project is presented in Table 11. The analysis is based on construction and operation of the project by the Trinity County Waterworks District No. 1.

Construction funds were assumed to be obtained from the State under terms of the Davis-Grunsky Act as follows:

Initial construction capital cost	$ 761,000
Grants	83,000
Loan (3.3%)	$ 678,000

Payments on the principal and interest would be deferred for 10 years to allow the district to discharge its existing debt. By the end of the 10-year period, the amount owed on the Davis-Grunsky loan would have increased to about $930,000 which could be paid off in 40 annual installments of $42,100. At the end of the first ten years of project operations, enlargement of water treatment facilities at a cost of $100,000 would be required; it was assumed that this expansion would be financed from private sources over a 40-year repayment period at an annual interest rate of 4 percent. This $100,000 loan would require an annual payment of about $5,100, bringing the total annual cost of debt retirement to $47,200 for the 40-year repayment period.

Future expenditures for replacement of the existing distribution system were based on establishment of a 4 percent sinking fund which requires annual payments of $8,200, beginning in 1972. Operation, maintenance, and replacement costs were based on the detailed analyses described in Chapter V.

The repayment analysis in Table 11 shows that the Ewing Project, financed with a Davis-Grunsky loan, could be repaid by the moderate adjustment of the water rate schedule described previously, combined with an initial tax rate of $1.35. The tax rate could be reduced after about 20 years, and eventually could be lowered to about 40 cents. The tax rate for support of the Trinity County Waterworks District No. 1 has ranged from $2.96 to 72 cents during the 1953-64 period and has averaged about $1.10 for the last five years.

A second repayment analysis was made, based on project financing from an unspecified source at an annual interest rate of 4 percent. It was found that, retaining the same water rate schedule used for the first repayment analysis, the initial tax rate would have to be increased to about $1.50 and could ultimately be reduced only to about 90 cents.

Table 12 compares the required revenues for the two interest rates considered with the average revenues for the 1959-64 period with the existing system.

TABLE 11

EWING PROJECT REPAYMENT ANALYSIS

Year	REVENUE					EXPENDITURES					SUMMARY		
	Assessed Valuation	Tax Rate	Tax Revenue	Revenue from Water Sales	Total Revenue	General O M & R	Replacement of Existing System	Repayment of Existing Debt	Repayment of Ewing Project Debt*	Total Expenditures	Net Annual Revenue	Interest on Balance at 4%	Reserve Balance at End of Year
1967-68	$ 770,000	$1.35	$ 10,400	$ 34,000	$ 44,400	$ 31,700	0	$ 13,600	0	$ 45,300	$ - 900	---	$ - 900
-69	820,000		11,100	37,000	48,100	32,500	0	13,200	0	45,700	2,400	---	1,500
-70	880,000		11,900	39,500	51,400	33,300	0	12,800	0	46,100	5,300	100	6,900
-71	930,000		12,600	42,000	54,600	34,100	0	12,400	0	46,500	8,100	300	15,300
-72	990,000		13,400	44,500	57,900	34,900	0	12,000	0	46,900	11,000	600	26,900
-73	1,040,000		14,000	47,000	61,000	35,700	$ 8,200	11,600	0	55,500	5,500	1,100	33,500
-74	1,090,000		14,700	49,500	64,200	36,500		11,200	0	55,900	8,300	1,300	43,100
-75	1,140,000		15,400	52,000	67,400	37,300		10,800	0	56,300	11,100	1,700	55,900
-76	1,190,000		16,100	54,500	70,600	38,100		10,400	0	56,700	13,900	2,200	72,000
-77	1,230,000		16,600	57,000	73,600	38,900			0	47,100	26,500	2,900	101,400
1977-78	1,270,000		17,200	59,500	76,700	39,400			$ 47,200	94,800	-18,100	4,000	87,300
-79	1,310,000		17,700	61,500	79,200	39,700				95,100	-15,900	3,500	74,900
-80	1,350,000		18,200	63,500	81,700	40,000				95,400	-13,700	3,000	64,200
-81	1,390,000		18,800	66,000	84,800	40,400				95,800	-11,000	2,600	55,800
-82	1,420,000		19,200	68,000	87,200	40,800				96,200	- 9,000	2,200	49,000
-83	1,460,000		19,700	70,000	89,700	41,200				96,600	- 6,900	2,000	44,100
-84	1,500,000		20,300	72,500	92,800	41,700				97,100	- 4,300	1,800	41,600
-85	1,530,000		20,700	74,500	95,200	42,200				97,600	- 2,400	1,700	40,900
-86	1,570,000		21,200	76,500	97,700	42,700				98,100	- 400	1,600	42,100
-87	1,600,000	1.35	21,600	78,500	100,100	43,200				98,600	1,500	1,700	45,300
1987-88	1,640,000	0.85	13,900	80,500	94,400	43,800				99,200	- 4,800	1,800	42,300
-89	1,670,000		14,200	82,500	96,700	44,400				99,800	- 3,100	1,700	40,900
-90	1,700,000		14,400	84,500	98,900	45,000				100,400	- 1,500	1,600	41,000
-91	1,730,000		14,700	86,500	101,200	45,600				101,000	200	1,600	42,800
-92	1,760,000	0.85	15,000	88,000	103,000	46,200				101,600	1,400	1,700	45,900
-93	1,790,000	0.45	8,100	90,000	98,100	46,900				102,300	- 4,200	1,800	43,500
-94	1,820,000		8,200	91,500	99,700	47,600				103,000	- 3,300	1,700	41,900
-95	1,860,000		8,400	93,000	101,400	48,300				103,700	- 2,300	1,700	41,300
-96	1,890,000		8,500	95,000	103,500	49,000				104,400	- 900	1,600	42,000
-97	1,920,000	0.45	8,600	97,000	105,600	49,700				105,100	500	1,700	44,200
1997-98		0.40	7,700		104,700	50,100				105,500	- 800	1,800	45,200
-99						50,200				105,600	- 900	1,800	46,100
-00						50,300				105,700	- 1,000	1,800	46,900
-01						50,400				105,800	- 1,100	1,900	47,700
-02						50,500				105,900	- 1,200	1,900	48,400
-03						50,700				106,100	- 1,400	1,900	48,900
-04						50,800				106,200	- 1,500	2,000	49,400
-05						51,000				106,400	- 1,700	2,000	49,700
-06						51,100				106,500	- 1,800	2,000	49,900
-07						51,300				106,700	- 2,000	2,000	49,900
2007-08						51,400				106,800	- 2,100	2,000	49,800
-09						51,600				107,000	- 2,300	2,000	49,500
-10						51,700				107,100	- 2,400	2,000	49,100
-11						51,900				107,300	- 2,600	2,000	48,500
-12						52,000				107,400	- 2,700	1,900	47,700
-13						52,200				107,600	- 2,900	1,900	46,700
-14						52,300				107,700	- 3,000	1,900	45,600
-15						52,500				107,900	- 3,200	1,800	44,200
-16						52,600				108,000	- 3,300	1,800	42,700
-17	1,920,000	0.40	7,700	97,000	104,700	52,800	8,200		47,200	108,200	- 3,500	1,700	40,900

* Initial $677,000 loan at 3.3%, all payments deferred for 10 years; $100,000 loan in 1977 for expansion of treatment plant at 4.0%.

TABLE 12

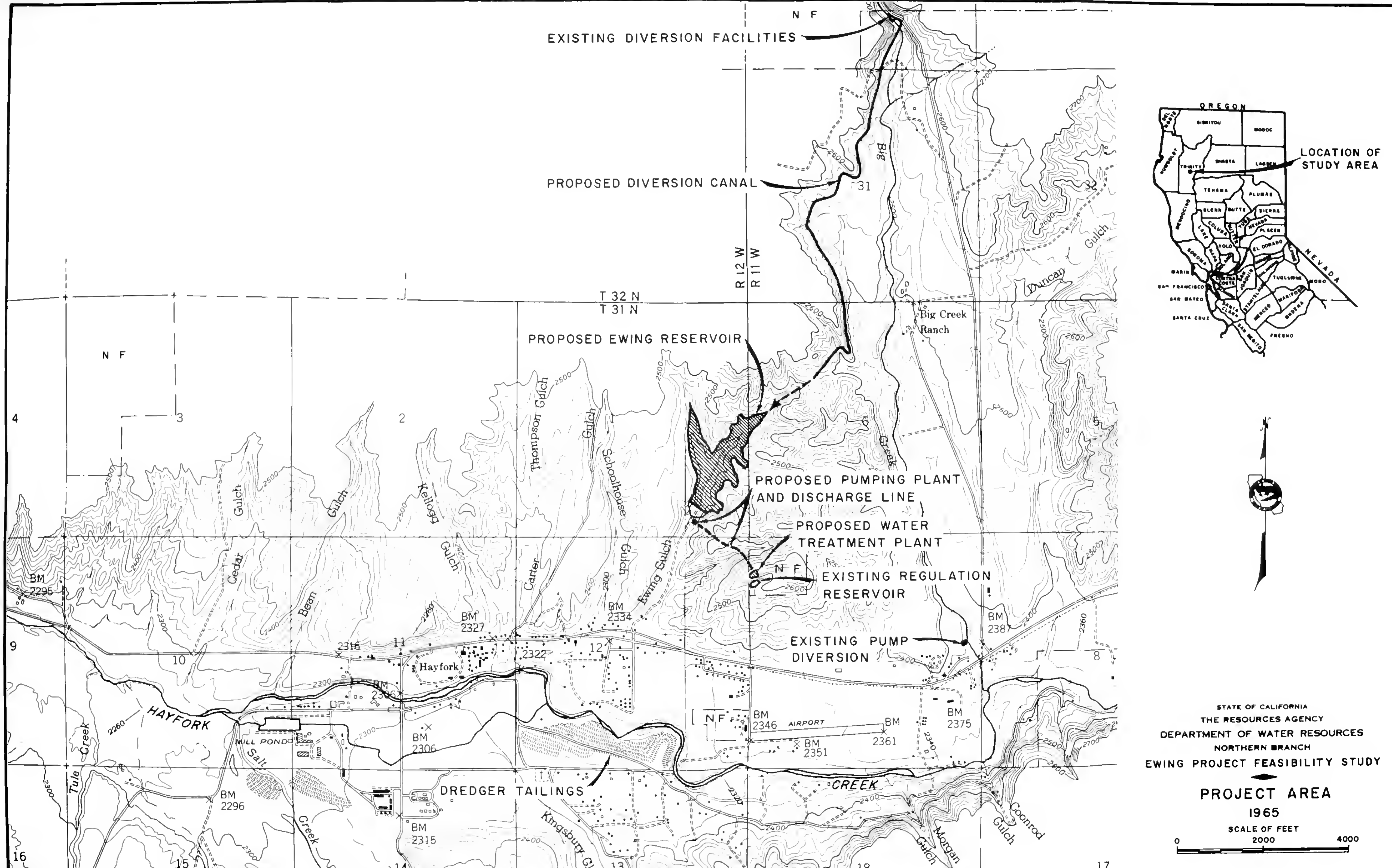
REQUIRED WATER CHARGES AND TAXES UNDER
EWING PROJECT CONDITIONS

	Average Monthly Cost of Water Service (Dollars per service) Taxes	Water Charges	Total	Average Annual Use Per Service (Acre-feet)	Average Total Cost of Water ($ per acre-foot)
1959-64 average	$2.10	$5.75	$7.85	0.43	$220
Ewing Project (3.3% interest)					
Initial (1967)	$2.10	$7.20	$9.30	0.56	$200
Maximum (1987)	2.10	8.10	10.20	0.69	180
Mean (1967-2017)	1.40	8.10	9.50	0.70	160
Ewing Project (4% interest)					
Initial (1967)	$2.50	$7.20	$9.70	0.56	$210
Maximum (1992)	2.50	8.30	10.80	0.72	180
Mean (1967-2017)	2.00	8.10	10.10	0.70	170

Table 12 shows that construction of the Ewing Project would result in increased cost to the consumer amounting to an average of about $1.70 per month if the project were financed with a 3.3 percent loan, or $2.30 per month if 4 percent financing were obtained. However, the Ewing Project would provide for greater per capita use, and the unit cost of water could actually be lowered.

Project Implementation

Two of the three tests of financial feasibility have been considered in the preceding paragraphs. First, it was concluded that sufficient capital could be made available to finance construction. Second, it was found that revenue sufficient to recover reimbursable project costs could be derived without increasing the burden on individual water users to an unreasonable level. The third, and most relevant, test of financial feasibility asks whether the beneficiaries are willing and able to pay the costs of the project. This question will have to be decided by the residents of the Trinity County Waterworks District No. 1.


EXISTING DIVERSION FACILITIES
PROPOSED DIVERSION CANAL
PROPOSED EWING RESERVOIR
PROPOSED PUMPING PLANT AND DISCHARGE LINE
PROPOSED WATER TREATMENT PLANT
EXISTING REGULATION RESERVOIR
EXISTING PUMP DIVERSION
DREDGER TAILINGS
LOCATION OF STUDY AREA
T 32 N
T 31 N
R 12 W
R 11 W
Hayfork
HAYFORK CREEK
MILL POND
AIRPORT
Big Creek Ranch
Big Creek
Duncan Gulch
Thompson Gulch
Schoolhouse Gulch
Ewing Gulch
Carter Gulch
Kellogg Gulch
Cedar Gulch
Bean Gulch
Tule Creek
Salt Creek
Kingsbury Gl.
Morgan Gulch
Coonrod Gulch
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OREGON
NEVADA
STATE OF CALIFORNIA
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DEPARTMENT OF WATER RESOURCES
NORTHERN BRANCH
EWING PROJECT FEASIBILITY STUDY
PROJECT AREA
1965
SCALE OF FEET
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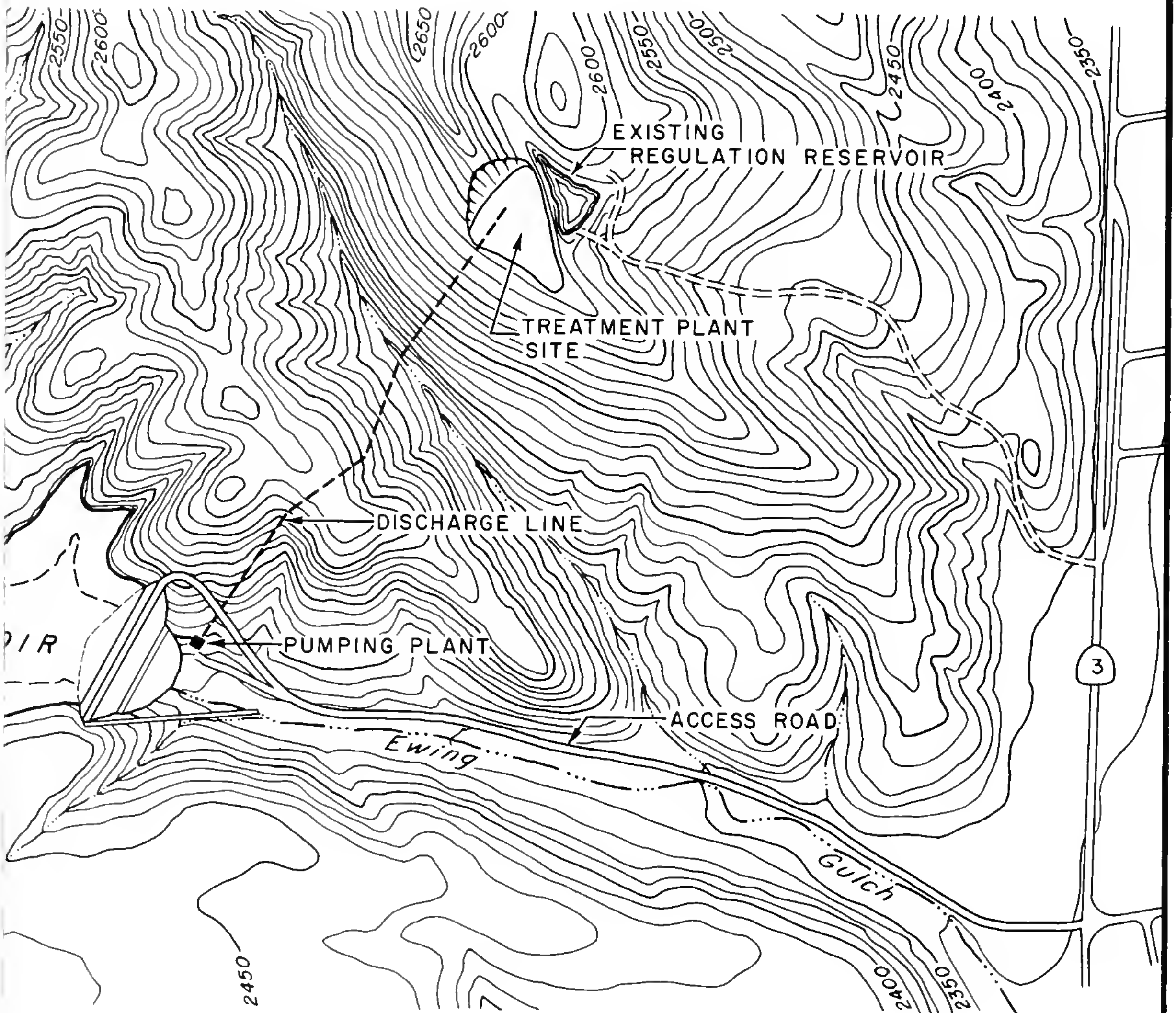
2000
4000



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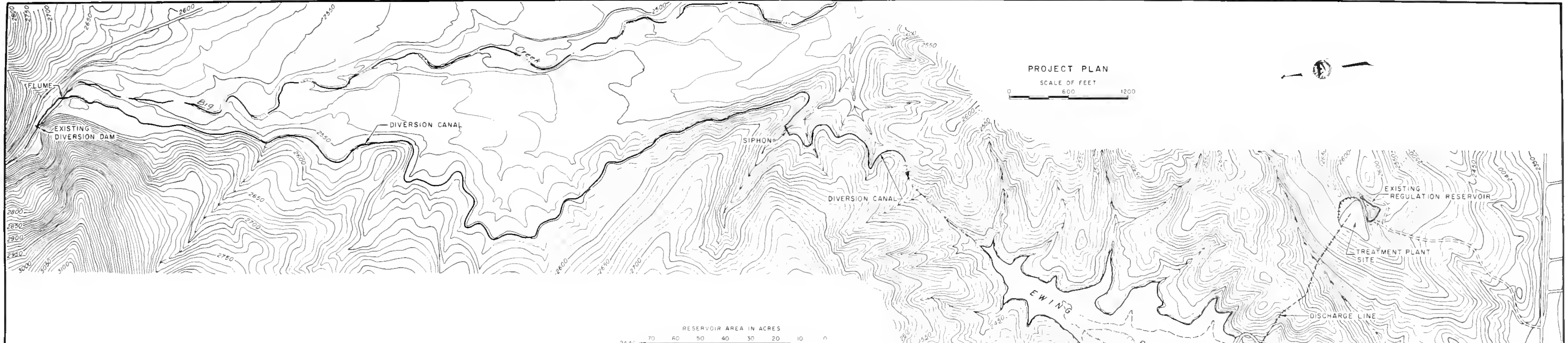
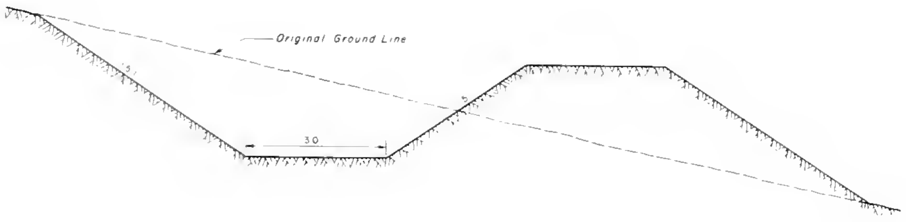
DEPARTMENT OF WATER RESOURCES
NORTHERN BRANCH

EWING PROJECT FEASIBILITY STUDY

PROJECT PLAN
1965





TYPICAL SECTION OF DIVERSION CANAL

SCALE OF FEET
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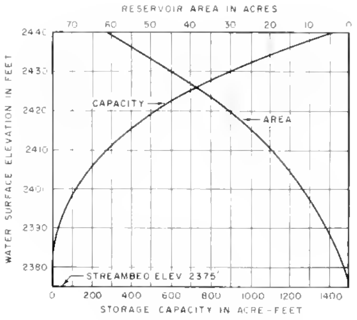

AREA – CAPACITY CURVES

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PROJECT PLAN
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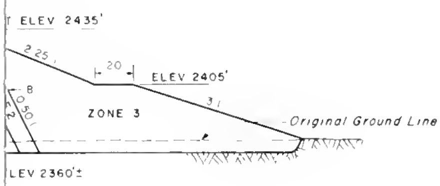
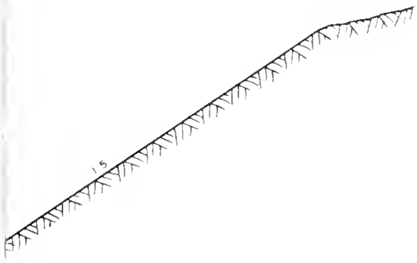


ECTION

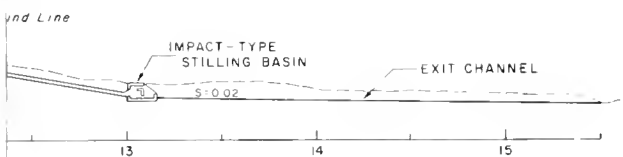
100



-B'

T

10



LLWAY

100

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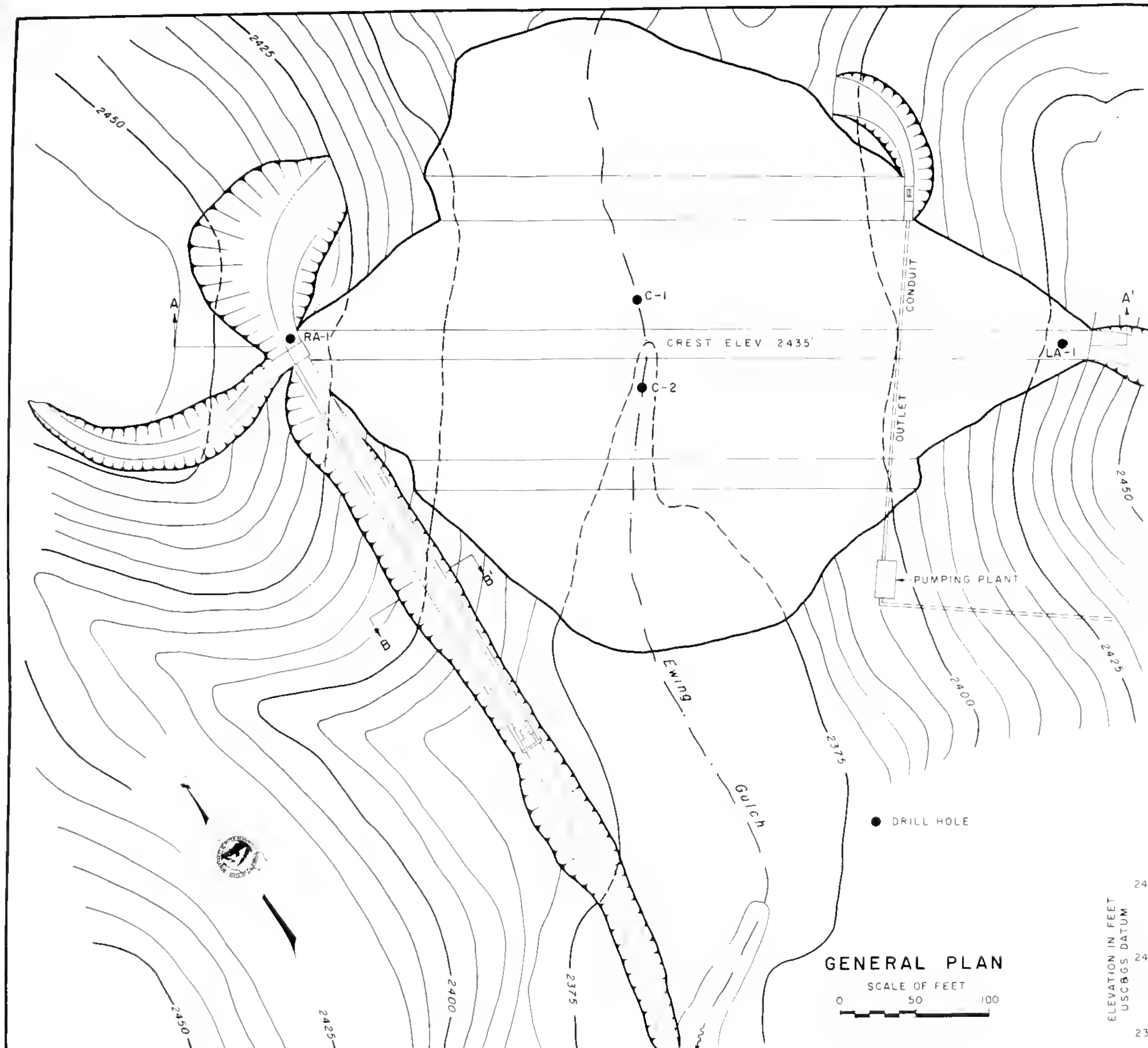
EWING PROJECT FEASIBILITY STUDY

EWING DAM
GENERAL PLAN AND SECTIONS

1965



GENERAL PLAN

SCALE OF FEET

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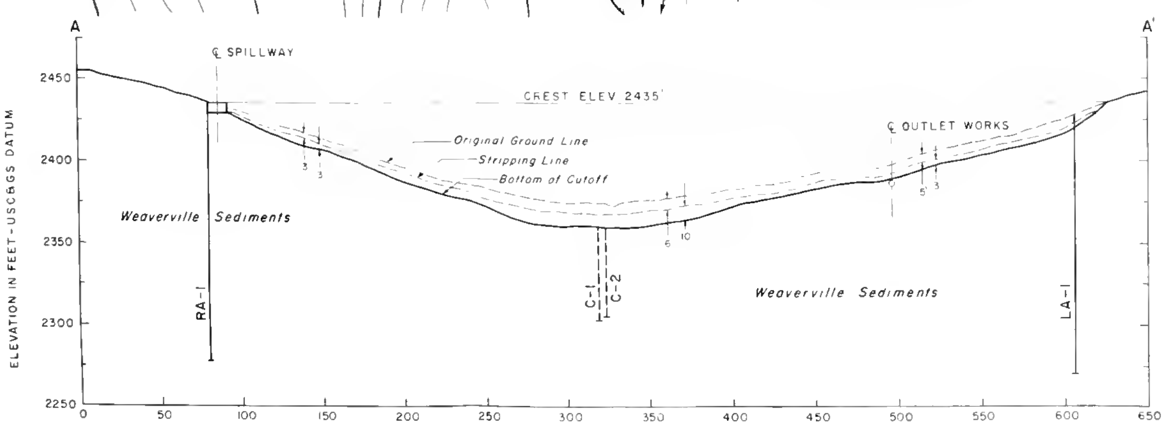
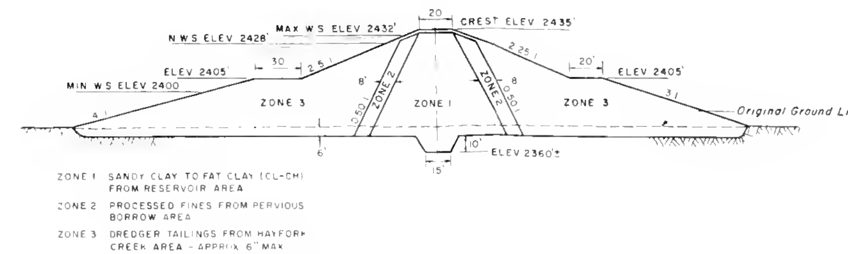


SECTION A-A'



MAXIMUM DAM SECTION

SCALE OF FEET

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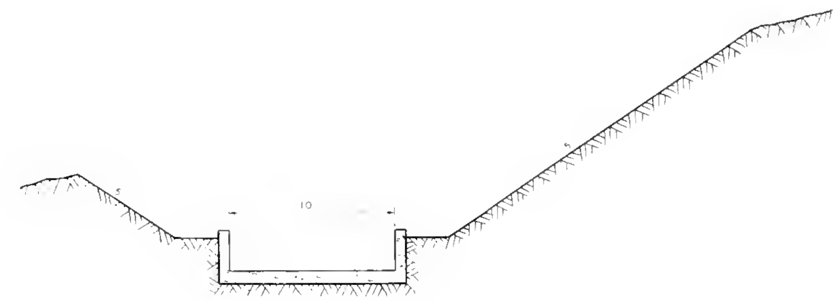

SECTION B-B'

SCALE OF FEET

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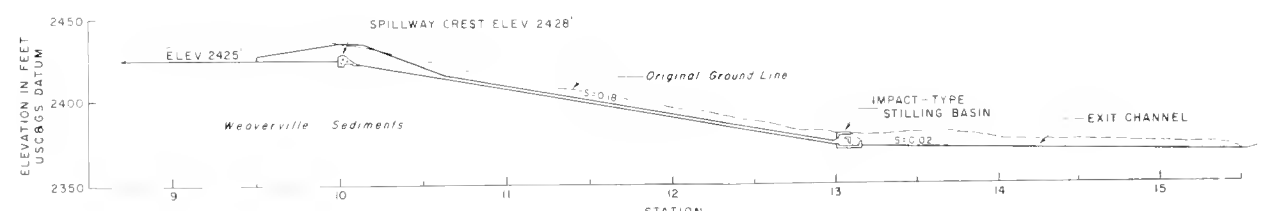

PROFILE OF SPILLWAY

SCALE OF FEET

0 50 100

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EWING DAM
GENERAL PLAN AND SECTIONS
1965